PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

June 1959

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P&E

IN THIS ISSUE—

URETHANE FOAMS,
BUTYRATE, MARKING,
& REINFORCED PLASTICS

Canadian General Electric Co., Ltd.

New streamlined transformers, molded in Epon resins, have superior insulation and dielectric strength. Accuracy and over-all performance are greatly improved.

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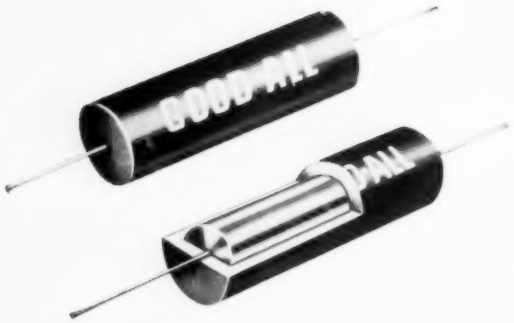

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IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Toronto

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

JUNE 1959

VOLUME V

NUMBER 6

feature articles:

rigid urethane foams p. 31

BY DR. ANTOINE KHAWAM

An up-dated comprehensive review of the entire subject, including a discussion of basic urethane chemistry, foam formulations, foam preparation, chemical and physical properties of the foam, and current and potential industrial applications.

some tensile properties of cellulose acetate butyrate p. 36

BY R. E. ELY

Results of an investigation are given, covering a wide range of tensile testing speeds, temperatures, and stress rates.

selecting the proper marking process for plastics p. 39

BY H. O. BATES and W. A. HEINE, JR.

Marking equipment for hot-stamping of thermoplastics is described. A technique for selecting the process to be used is presented, and limitations and possible draw-backs of the system are discussed in detail.

factors affecting durability of glass-reinforced polyester plastics p. 42

BY A. L. SMITH and J. R. LOWRY

Properties of polyester resins and blends can be related to their weathering performance in glass-reinforced plastics on the basis of exposure tests in Bristol, Pa., and in Florida. An attempt has been made to relate physical and chemical properties of polyesters to their durabilities when exposed to sunlight, wind, rain, temperature extremes, or any combination of these conditions.

guest editorial:

clarifying u.l's position on plastics in air-conditioners p. 49

BY G. H. POPE

engineering forum:

machinery maintenance p. 51

BY GEORGE E. VENTZ

Hydraulic systems—pump failures and sluggish operations.

exploring fabrication techniques:

fluorocarbon resins p. 52

BY L. J. ZUKOR

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heating table speeds hot-punching process p. 57

reinforced plastic pavilion p. 58

Hoehn replaces Blitz on PT Editorial Advisory Board p. 52

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Opinions expressed by contributors do not necessarily reflect those of our editors

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Photo courtesy Bedminster Sound Corp., Belleville, N. J.

Now, hear this—for stereo with better audio!

There can be no compromise with quality when you're working with stereo. Reason: the buyer of a stereo record *expects* the ultimate in sound reproduction. He expects audio quality *far better* than he's ever heard before. Thus, stereo calls for improved record compounds.

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Pliovic—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Letters to the Editors

Previews of Next Month

The July issue will feature the following articles:

Use of Clays in Vinyl Compounds. E. W. Schwartz, In Charge of Tech. Service and Sales—Rubber and Plastics, Southern Clays, Inc., New York, N. Y.

Some of the more important uses for clay and its calcined derivatives are described and discussed, together with typical vinyl formulations. Processing variables that affect formulations are presented as the starting step in balancing formulations for specific applications.

•

Standard Injection Machine Procedures A. R. Morse, Sales Engr., Injection Molders Supply Co., Cleveland, Ohio.

Recommended standard procedures for start-up, shut-down, and purging of injection machines are presented. Problems discussed include injection pressures and nozzle slugs during start-up; heat settings, interruptions, and power failures in shut-downs; and purging compounds, dirt, streaks, contamination, plunger galding, black specks and splay marks, and incorrect heater ratings as troublesome factors during purging of injection machines.

•

Determining Epoxy Contents of Cured and Uncured Resins. H. C. Anderson, Physical Chemist, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

Studies of polymerizations with amine curing agents can be made by means of a relatively-simple chemical test method. The test procedure is described in detail and test variables are covered (including reaction time, grinding of resin specimens, and effect of alcohols. Corroboration of findings with infra-red test results is shown to be quite good.

•

Locating the Market for Plastics Products. Dr. Jay M. Gould, Market Research Director, PLASTICS TECHNOLOGY.

Much statistical data is available already, and requires only proper interpretation to make it valuable and useful in determining the size of the market for specific fields of application. In addition, market statistics can be used to locate and identify plants using plastic components in their end-products.

•

The Guest Editorial will be: **Misuse of Polyethylene Poses a Serious Problem.** V. D. McCarthy, Mgr. of Polythylene Sales, U. S. Industrial Chemicals Co., New York, N. Y.

Likes Dry-Color Dispersion Article

Dear Sir:

In the April issue (p. 27) there was a very good article by A. R. Morse titled "A New Look at Dry-Color Dispersion." We feel that Mr. Morse should be congratulated on his article and that his article accomplished its purpose very well.

There is one minor correction which we feel should be made to Figure 1. The breaker plate titled "Ferro Type" is an early form of the breaker plate titled "Venturi Type." The Venturi type was also developed by Ferro Corp. It has been found to be superior in use to the others shown.

Even though, as Mr. Morse states in his article, he does not offer any solutions to the problems, we are glad to see them stated again so eloquently. Perhaps articles of this type will generate the interest which is necessary before the ultimate solution to the problems can be arrived at.

J. E. Simpson
Color Division,
Ferro Corporation
Cleveland, Ohio

• • •

Corrects Data on DeMattia Machine

Dear Sir:

Confirming our telephone conversation, we wish to state that when we gave you the additional information on the DeMattia machine, we missed out on one point of the specifications covering the 12-16 oz. Model MI machine.

In your May issue you gave the specifications of the Model M machine which dry-cycled at 360 shots per hour. The Model MI machine dry-cycles at 720 shots per hour, and we should have called your attention to this fact in our letter (to you) of January 26.

Will you, therefore, kindly change your records on this MI machine accordingly.

J. L. Hutchings
Brosites Machine Co., Inc.
New York, N. Y.

(We print this letter to inform our readers of the necessary correction in the published "PT's Comparative Data on 1959 Injection Molding Machines."—Editor)

Addresses of Abstracted Magazines

Dear Sir:

Can you supply me with the addresses of those "plastic" magazines which you abstract? Several times I have wanted prints of articles, but do not know where the offices of the publications are located.

H. L. Gorman, Lab. Supervisor
Acheson Dispersed Pigments
(Ohio) Co.,
Xenia, Ohio

(Complete addresses of abstracted publications appear quarterly. Intervening months carry a note as to the latest and next future issue in which the complete listing appears. Incidentally, the complete listing appears in this issue.—Editor)

• • •

Information Wanted

Dear Sir:

We are presently making a board for which we use ⅜" x 18" x 30" plywood with birch veneer. This board must be smoothed, edges routed, and varnished. The cost is about $3.50 per piece.

It appears to us we might find a plastic which would have the same rigidity requirements for a board this large (18" x 30"). Can you suggest such a material?

Any assistance you may offer will be greatly appreciated.

Arthur Dunham
Craft Shop
Taylor, Mich.

(Can our readers offer any suggestions? These can be sent either directly to the inquirer, or to this office for transmittal to Mr. Dunham.—Editor)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

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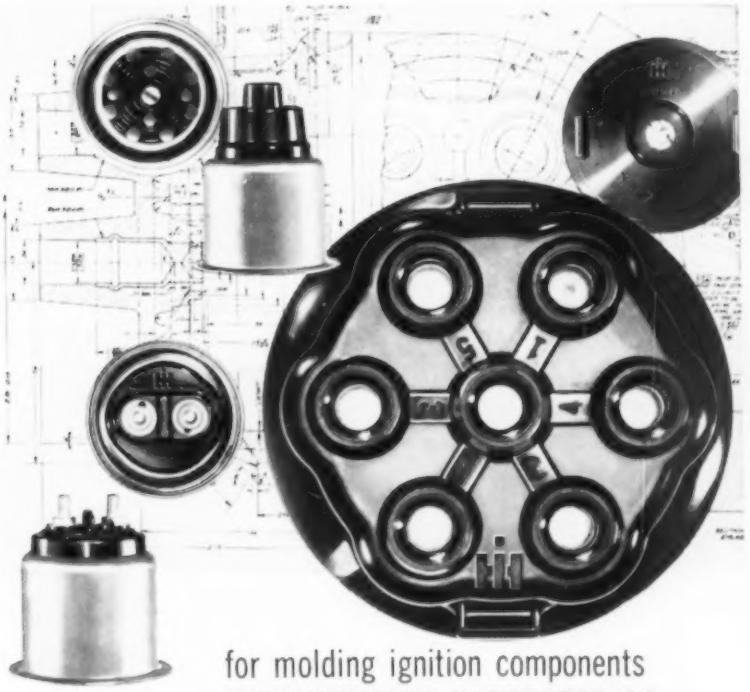

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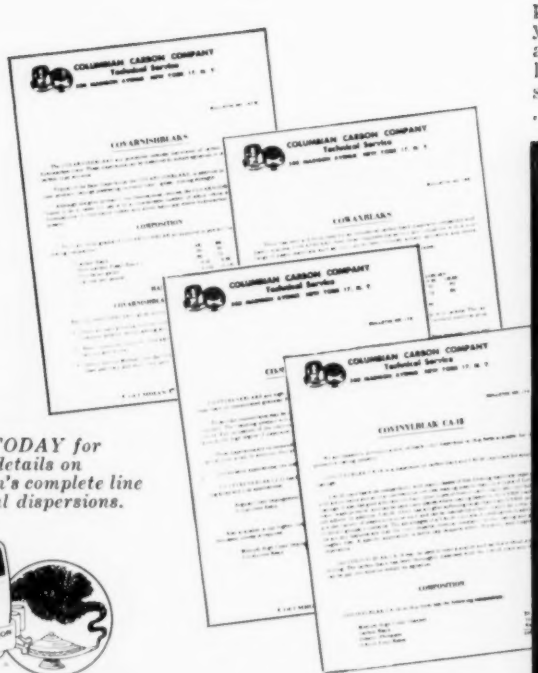

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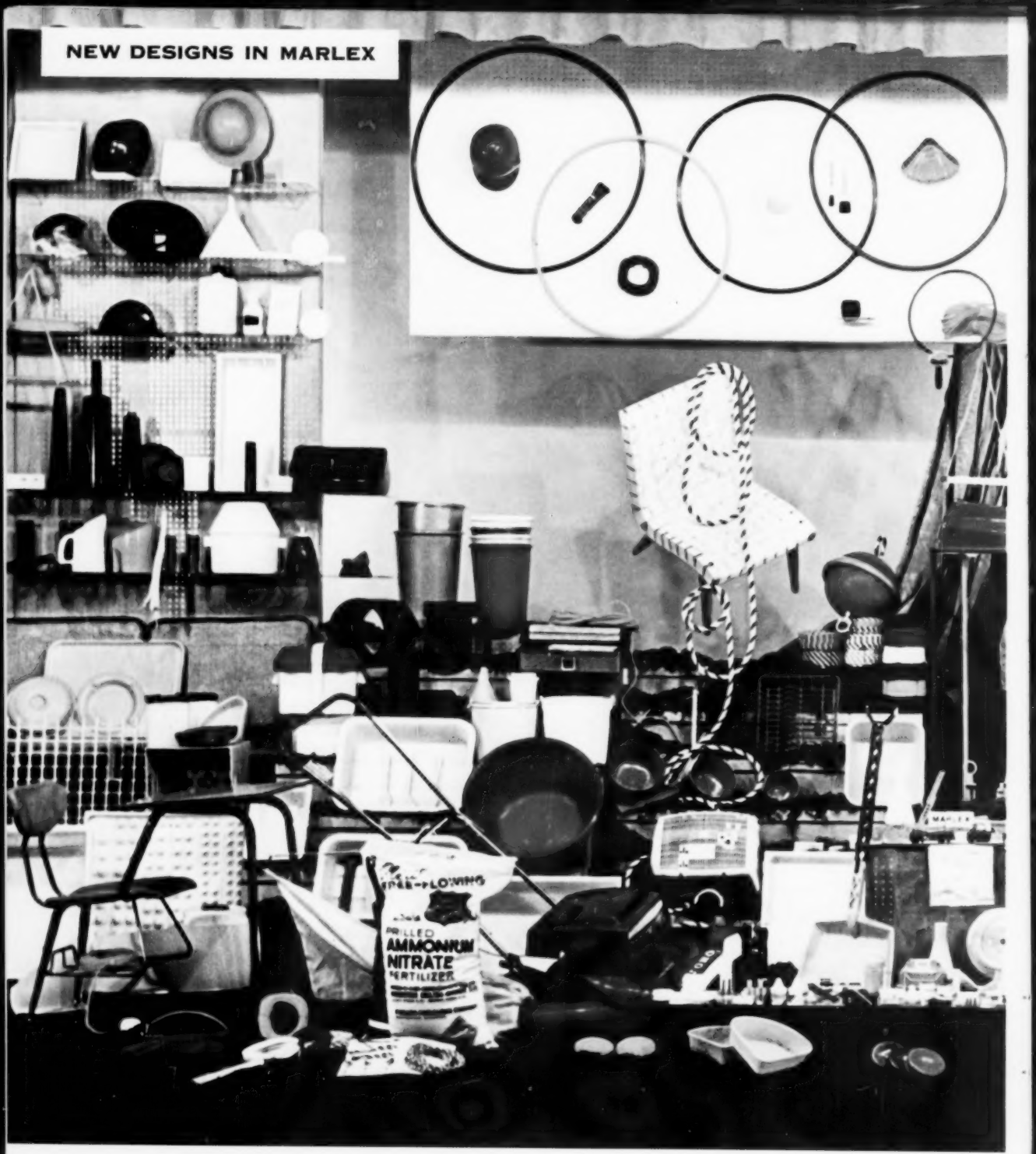

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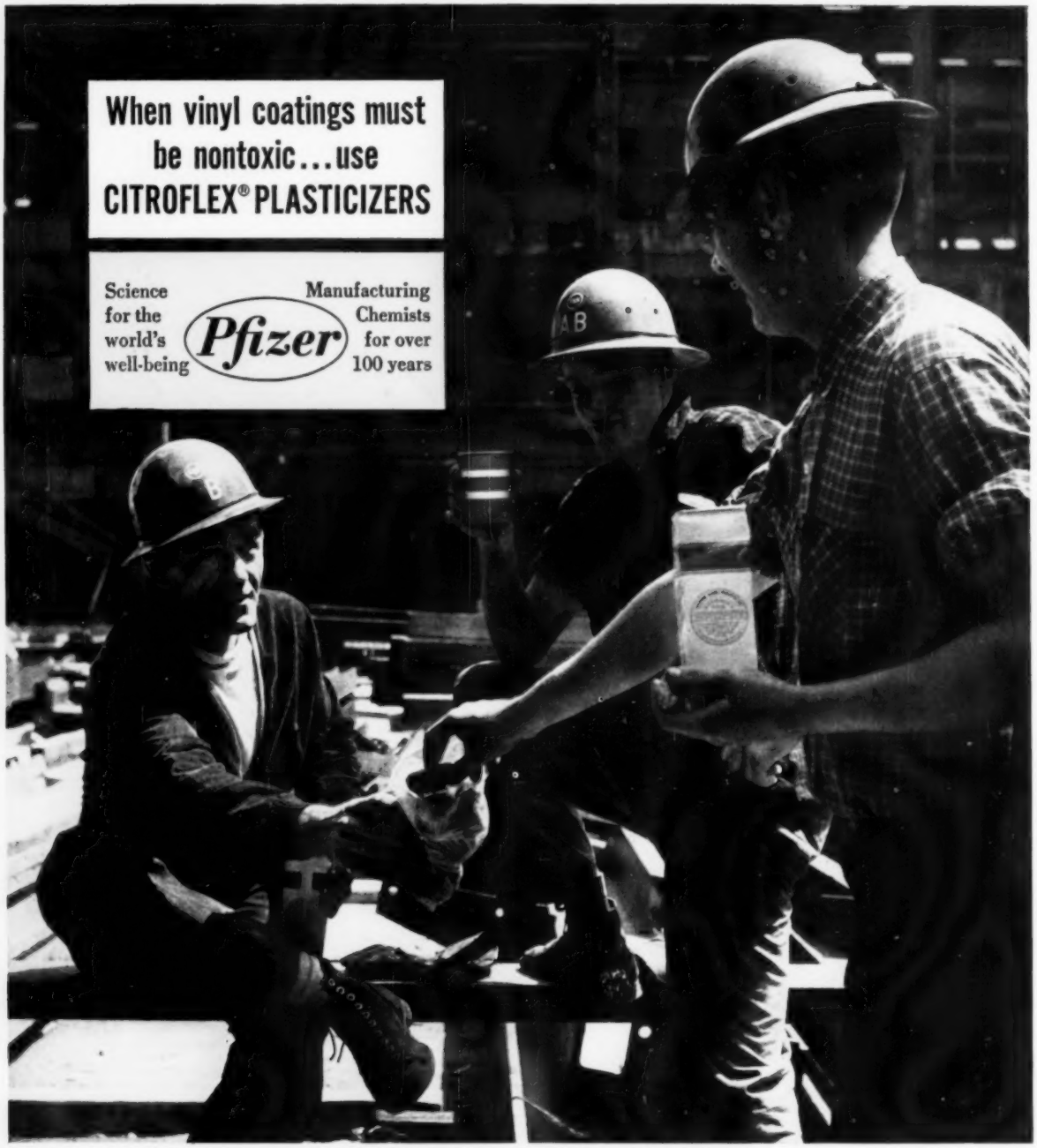
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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

JUNE, 1959

EDITORIAL: Achievement Awards, 1958-1959

Our "Achievement Awards in Plastics Technology" program for accomplishments in the years 1958-1959 is under way. These awards are made to stimulate, encourage, and duly publicize new techniques in plastics processing and fabricating that can lead to new advances in technology for the entire industry.

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The Awards are made in two classes:

Class 1. New Developments in Plastics Processing (made by an individual or a firm). This includes all methods whereby a plastic material, as furnished by the supplier, is molded, extruded, formed, or otherwise shaped into a finished or semi-finished part.

Class 2. New Developments in Plastics Fabricating (made by an individual or a firm). This includes all methods such as decorating, bonding, assembly, or others whereby a semi-finished part is transformed into a finished, saleable product.

Entries may be submitted by an interested person or firm before December 31, 1959, the closing date, to: Executive Secretary, Achievement Awards in Plastics Technology, c/o PLASTICS TECHNOLOGY, at our address.

All entries are expected to furnish suitable proof of development date, and supply further data and illustrative material to substantiate their claims.

The first award in each Class is a bronze medal, while secondary awards will consist of suitably-inscribed certificates. The awards will be presented at a special luncheon meeting in February 1960. Incidentally, the entries will be judged by a special panel of recognized authorities selected from the domestic plastics industry.

The winners will be given fitting publicity in our February 1960 issue, with due recognition of the persons responsible and the engineering importance of the developments. In addition, exhaustive records will be kept on the dates and other particulars for each entry development. This will protect the original developer in case of copies that are afterwards claimed as "firsts" and exploited by the copyists.

The rules for the Achievement Awards competition are simplicity itself. While formal entry blanks are available, their use is not required—a letter is sufficient giving a brief description of the development and including corroborative material, as mentioned in the italicized paragraph above.

•

While we have received many entries for the award program, we know of many other developments that have not been entered. We respect confidences, but urge that "secrets" be re-evaluated to determine whether they can be entered in this competition!

Arthur M. Merrill
Editor

Grueling use-test pits monomeric vs. polymeric plasticizers

Some years ago a vinyl upholstery manufacturer decided to field-test new materials for truck and transportation upholstery using a wide variety of monomeric and polymeric plasticizers, including Plastolein 9720. To compare *permanence* and *durability,* the different materials were installed on city bus drivers' seats. Here, seat upholstering would certainly be exposed to extraordinary abuse almost around the clock . . . continuous rubbing and flexing, city grime and grit, oil and grease.

After a certain period of time, all the upholstery containing monomeric plasticizers had failed. But all those made with polymerics, including Plastolein 9720, were still in excellent shape. With this evidence, the manufacturer concluded that only a polymeric plasticizer would meet its standards for truck and transportation upholstering, and protect its reputation. And Plastolein 9720 was chosen on the basis that it was the *lowest cost of all the fine polymerics tested.*

Today, Plastolein 9720 is *still* the lowest cost polymeric plasticizer, and is *still* being used by this and many other manufacturers in such heavy-duty goods. Why not check 9720 yourself? Write Dept. Q-6 for literature and sample.

PLASTOLEIN®
plasticizers

Emery Industries, Inc.

Organic Chemical Sales Department

Carew Tower, Cincinnati 2, O. • Vopcolene Div., Los Angeles
Emery Industries (Canada), London, Ontario—Export Department, Cincinnati

DOW | PLASTICS

Just announced . . . light-stable polystyrene hits new high in resistance to yellowing!

STYRON® 672 and STYRON 673

VERELITE

The introduction of Styron 672 Verelite and Styron 673 Verelite heralds a significant new advance in fluorescent lighting fixture materials. Both are new, light-stabilized formulations developed by Dow for such applications as light grids, diffusers, and folding curtains.

These new polystyrenes have been fully tested and proved. They exceed the specification adopted jointly by the National Electrical Manufacturers Association, Illumination Engineering Society and Society of Plastics Engineers. In light stability tests, for example, they exhibited a yellowing factor of 2.3 after 500 hours, well within the allowable maximum of 15. General purpose polystyrene formulations reach 15 after only 393 hours of exposure. Thus the non-yellowing characteristics of the Verelite formulations make them an excellent material for fluorescent applications.

Both Styron 672 Verelite, the molding formulation, and Styron 673 for extrusion are now available in a wide range of granulations to meet varying requirements. For more information, return the handy coupon below for technical data and prices.

The addition of these two new polystyrenes brings the already extensive line of Styron formulations to a total of 15. Another milestone for industry's fastest growing group of polystyrene formulations.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN

America's First Family of Thermoplastics

STYRON*

General Purpose
Styron 666
Styron 689 (Easy flow)

Medium Impact
Styron 330 (Easy flow)
Styron 777
Styron 369 (High heat)

High Impact
Styron 475
Styron 440 (Heat resistant)
Styron 440M (Easy flow)
Styron 480 (Extra-high impact)

Heat Resistant
Styron 683
Styron 700

Light-stable
Styron 672 (Verelite)
Styron 673 (Verelite)

TYRIL* • POLYETHYLENE • PVC

SARAN

ETHOCEL* • PELASPAN* • ZERLON*

*Trademark of The Dow Chemical Company

The Dow Chemical Company
Plastics Sales Department 2115DT6
Midland, Michigan

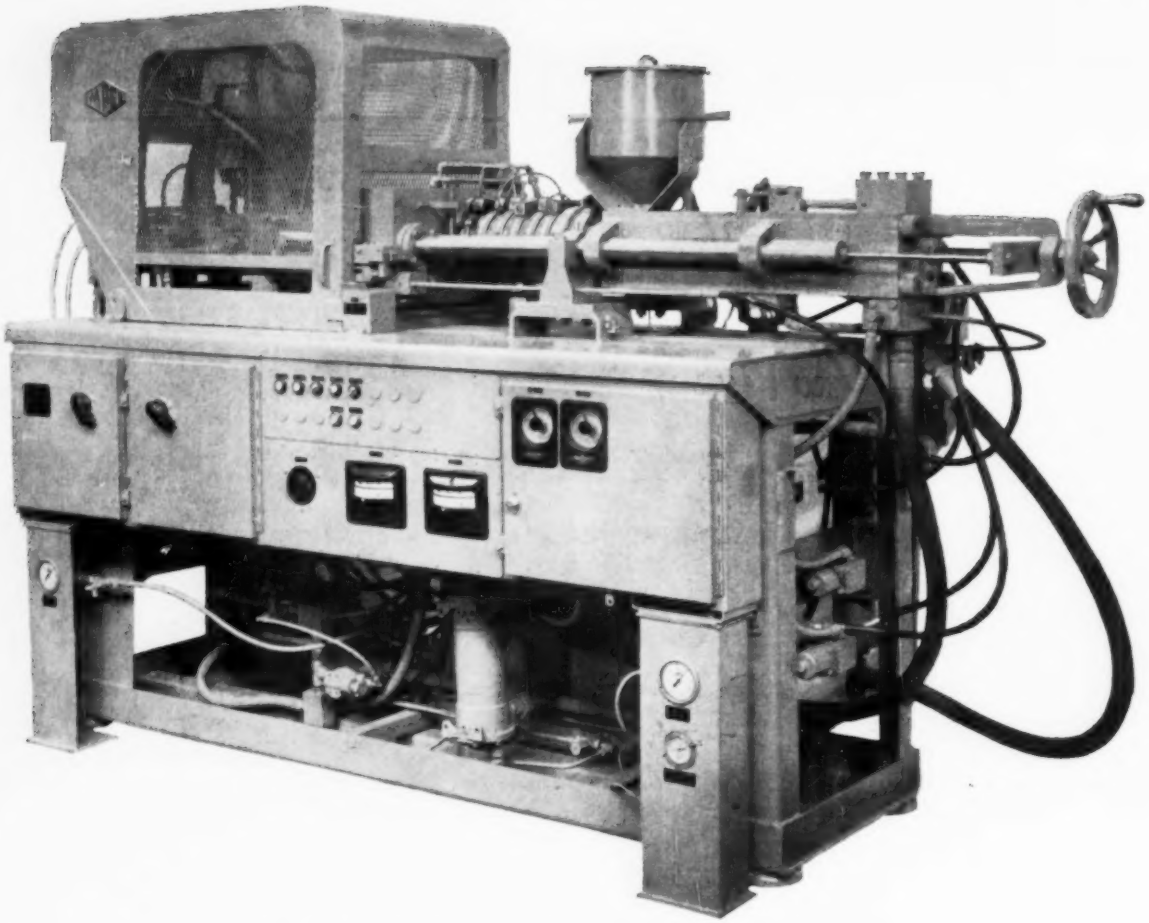
Please send me technical information and price schedule on Styron 672 Verelite and Styron 673 Verelite.

Name_____ Position_____

Firm_____

Address_____

City_____ Zone____ State_____



ANOTHER NEW IMPCO

Special Purpose Injection Molding Machine for Containerlike Molding

MODEL CA30-75

- 30-50 gram capacity
- 30 molding cycles per minute*
- shut-off nozzle for pre-pressurized molding
- simplified mold construction
- built-in die and platen cooling arrangement
- separate injection and clamp hydraulic circuits
- shock mounted control panel
- photo electric recycling monitor
- 75 ton clamp
- 9¼" stroke
- fully automatic

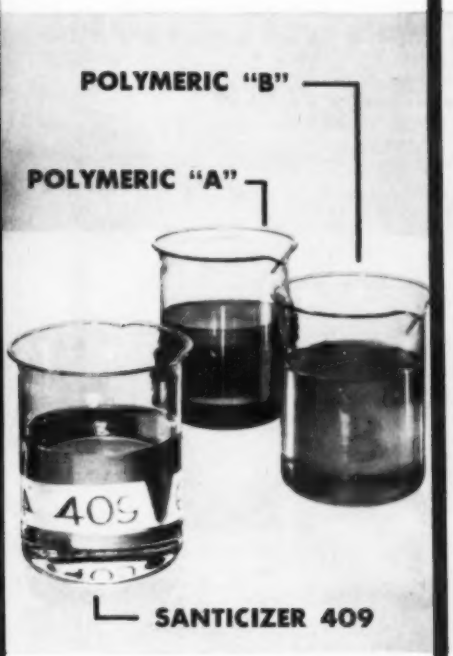
*dependent on material and mold construction

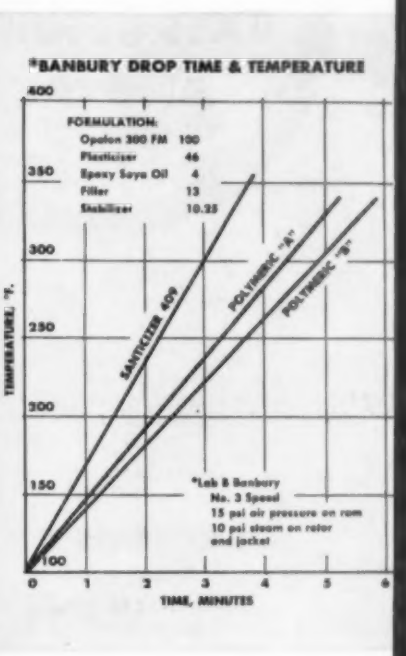
IMPCO IMPROVED MACHINERY INC.

NASHUA · NEW HAMPSHIRE

In Canada, Sherbrooke Machineries Limited, Sherbrooke, Quebec

Monsanto's new SANTICIZER 409 gives "high-priced" properties at the lowest cost of any polymeric plasticizer!





"Permanent" Benefits

To end summer "fog-up" on car windows from plasticizer volatilization (the most urgent problem confronting vinyl upholstery and coating producers), SANTICIZER 409 offers the best, lowest-cost answer. Simulated service tests prove it stays in the product longer than many higher-priced polymerics. SANTICIZER 409 is less volatile, does not migrate or exude—even in high humidity—as do many other polymeric plasticizers. Also, it is more resistant to extraction by soapy water, alkalies, solvents and oils, and has superior electrical properties.

Lighter Color, Lower Odor

Compared to two commercial polymeric plasticizers (above), SANTICIZER 409 has a lighter, clearer color and far less odor. Its good heat and light stability help finished products retain their true colors, plasticity, attractive appearance and other important physical properties. SANTICIZER 409 contains no flocculent matter or sediment to cause spotting in thin films, transparent sheeting and similar products. Its high purity contributes to excellent electrical properties in vinyl insulating compounds.

Fastest Fusion

SANTICIZER 409 speeds the fusion of vinyl compounds faster than many other polymerics. Its high solvating power, low viscosity and plasticizing efficiency may cut your processing time, or improve your compound's physical properties within your processing temperature limitations. SANTICIZER 409 mixes readily with a variety of monomeric plasticizers and is highly compatible with cellulose acetate butyrate, nitrocellulose, polyvinylidene chloride and PVC.

If you now use or can use a polymeric-type plasticizer, you can't afford *not* to evaluate new SANTICIZER 409. Use-rated and job-proved, it can give you exclusive advantages *at lowest cost* in products such as: electrical-grade plastisols; coatings for moisture and corrosive-fume protection of dishwashers, ventilator ducts and similar products; long-service profile extrusions such as refrigerator gasketing; coated fabrics, film and sheeting, adhesive-backed tapes and free films.

Write on your company letterhead for a sample of SANTICIZER 409 and compounding help from Monsanto's Plasticizer Council.

SANTICIZER: Monsanto T.M., Reg. U.S. Pat. Off.

Monsanto

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU

For Technical Bulletins, Use Coupon

Monsanto Chemical Company, Organic Chemicals Division
Plasticizer Dept. 4, St. Louis 66, Missouri

Please send me the ☐ Technical Bulletin on SANTICIZER 409

☐ Research Report on "Fogging in Automobiles"

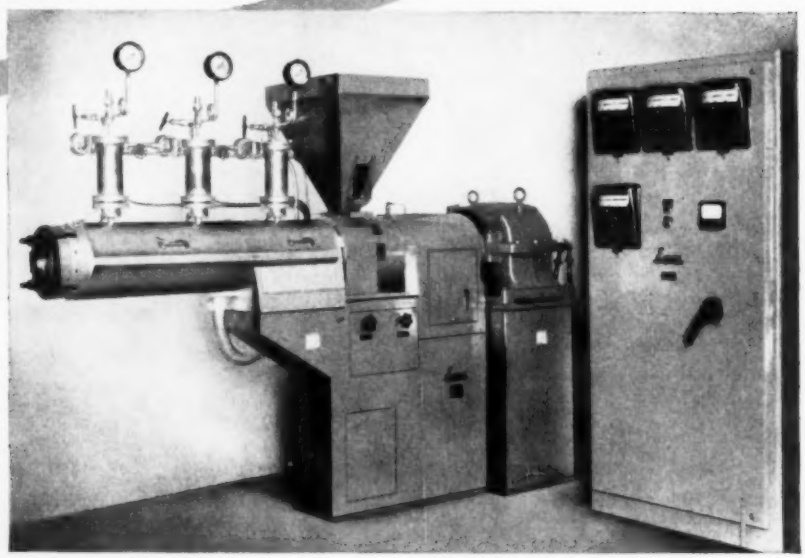
Name .....

Company .....

Address .....

City ..... *Zone* ..... *State* .....

YOUR CHECK LIST FOR THE FINEST IN EXTRUSION INSTALLATIONS AND ACCESSORIES



EGAN EXTRUDERS

☐ with "Willert Automatic Temperature Control" available in sizes from 2" through 12", vented or non-vented

SHEET EXTRUSION

☐ Dies—up to 60" wide
☐ Three Roll Finishing Units
☐ Automatic Shears
☐ Automatic Stackers

FILM EXTRUSION

☐ Dies—up to 120" wide
☐ Cooling & Take-Off Units
☐ Edge Trimmers
☐ Automatic Winders

POLYETHYLENE LAMINATING

☐ Laminating Dies—up to 120" wide
☐ Single or Double Unrolls
☐ Laminating Units
☐ Edge Trimmers & Trim Disposal Units
☐ Surface or Center Winders
☐ Cooling & Circulating Systems

LAYFLAT TUBING EXTRUSION

☐ Thin Wall Tubing Dies—up to 60" diameter
☐ Cooling Rings
☐ Converging Take-Off Units—up to 240" wide
☐ Surface or Center Shaft Winders

PIPE EXTRUSION

☐ Dies—up to 8" diameter (straight or offset)
☐ Cooling Tanks
☐ Pullers—roller or belt type
☐ Coilers—with level wind

Write, or Phone Randolph 2-0200, For Complete Information

Egan

FRANK W. EGAN & COMPANY

SOMERVILLE, NEW JERSEY

CABLE ADDRESS: EGANCO—SOMERVILLE (NJER)

REPRESENTATIVES: MEXICO, D.F.—M.H. GOTTFRIED, AVENIDA 16 DE SEPTIEMBRE; JAPAN—CHUGAI BOYEKI CO., TOKYO.
LICENSEE: GREAT BRITAIN—BONE BROS., LTD., WEMBLEY, MIDDLESEX.

U.S.I. POLYETHYLENE NEWS

A series for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

JUNE, 1959 U.S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Polyethylene pouch in a carton is being used to package frozen berries and fruits packed in syrup or sugar. The heat-sealed pouch is made of polyethylene-coated paper. The polyethylene coating holds liquids inside the pouch even when fruit is thawed. A tear string is built into the pouch for easy opening. A carton and overwrap complete the package.

The new pack reportedly offers substantial savings in packaging costs and labeling versatility.

Heat sealable multiwall bag features staggered plies at the open end, leaving polyethylene-coated inner ply exposed for direct heat sealing. After sealing, adhesive is applied to the tops of the outer plies. The entire lip is folded over and pasted to the outside of the bag. The sealing machine then adds a strip of gummed tape across the lip. The new coated bags are said to be especially suitable for packaging hygroscopic, deliquescent, corrosive and semiliquid products.

New bag sealer closes open-end shipping sacks with a polyethylene-coated kraft paper tape. The machine caps a 2.5 inch wide tape over the open end of flat tube bags by means of heat and pressure. The molten polyethylene seals stitching perforations, making a tight, moisture-resistant seal. The sealer operates at production line speeds and is said to cut costs over conventional wax sealing. Taped bags are expected to be used soon for shipping a wide range of chemicals and fertilizer materials.

U.S.I. Appoints Two

Ralph M. Knight

William H. Rader

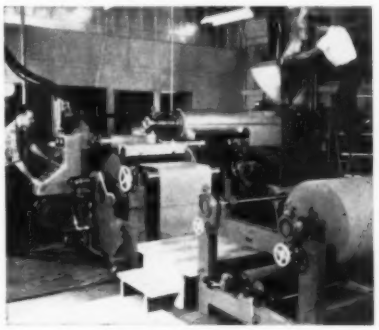
Ralph M. Knight has been named Manager of Polymer Planning and Applications by U.S.I. Mr. Knight will be responsible for planning and co-ordination of U.S.I.'s polymer development program. Mr. Knight previously has served U.S.I. in various polyethylene production capacities.

William H. Rader has been appointed PETROTHENE Polyethylene Production Manager. Mr. Rader has been Assistant Production Manager, and before that was in charge of polyethylene resin development programs at U.S.I.'s Tuscola plant.

Polyethylene-coated Milk Cartons Ready To Capture Volume

Leakproof Cartons Finding Favor with Retailers and Public

Polyethylene-coated milk containers are appearing on the market in selected areas and promise to take over a large share of the market now held by wax coated cartons. Although some machinery and production problems remain to be solved, the polyethylene-coated cartons have met with a favorable response with consumers and retail outlets.



The board coating machine above, located in U.S.I.'s Polymer Research Laboratory in Tuscola, runs at speeds equal to or greater than commercial equipment, duplicates the latter in everything but width.

Chief advantage of the polyethylene containers for both retailers and public is that the polyethylene cartons are virtually leakproof. Leakage of wax coated cartons has been a major problem. Polyethylene coatings not only provide stronger seals but also are more flexible at low temperatures and do not flake off as does wax. Polyethylene coated cartons are also scuff-resistant and may be printed easily.

Two Types Already on Market

Two types of containers are actually in use: a tetrahedron-shaped carton holding a pint or less, and a conventionally shaped full quart container. Initial use of the new polyethylene-coated milk cartons has been by dairies whose distribution systems involve rough or repeated handling that tends to damage conventional containers. New advances in container fabricating machinery, however, are expected to extend the use of polyethylene containers into major dairy markets.

Film Producer Offers Packaging Machinery Guide

A producer of polyethylene-coated films has issued a manual of automatic film packaging machinery available to users of polyethylene film packaging. The manual gives specifications for leading machines and describes such capabilities as speed, type of film that can be used, and package sizes each machine can handle.

The manual also contains conversion tables for calculating the yield of different film and paper combinations.

U.S.I. Opens New Sales Office in San Francisco

U.S.I. has established a new sales office in San Francisco to keep pace with the needs of customers in central and northern California and the Pacific Northwest. The address of the new office is: U. S. Industrial Chemicals Co., 220 Montgomery Street, San Francisco 4, California. The telephone is EXbrook 7-3250.

The new office will be tied into U.S.I.'s automated communications system through Pacific Coast headquarters in Los Angeles.

U.S.I. To Feature Cast Film At London Plastics Show

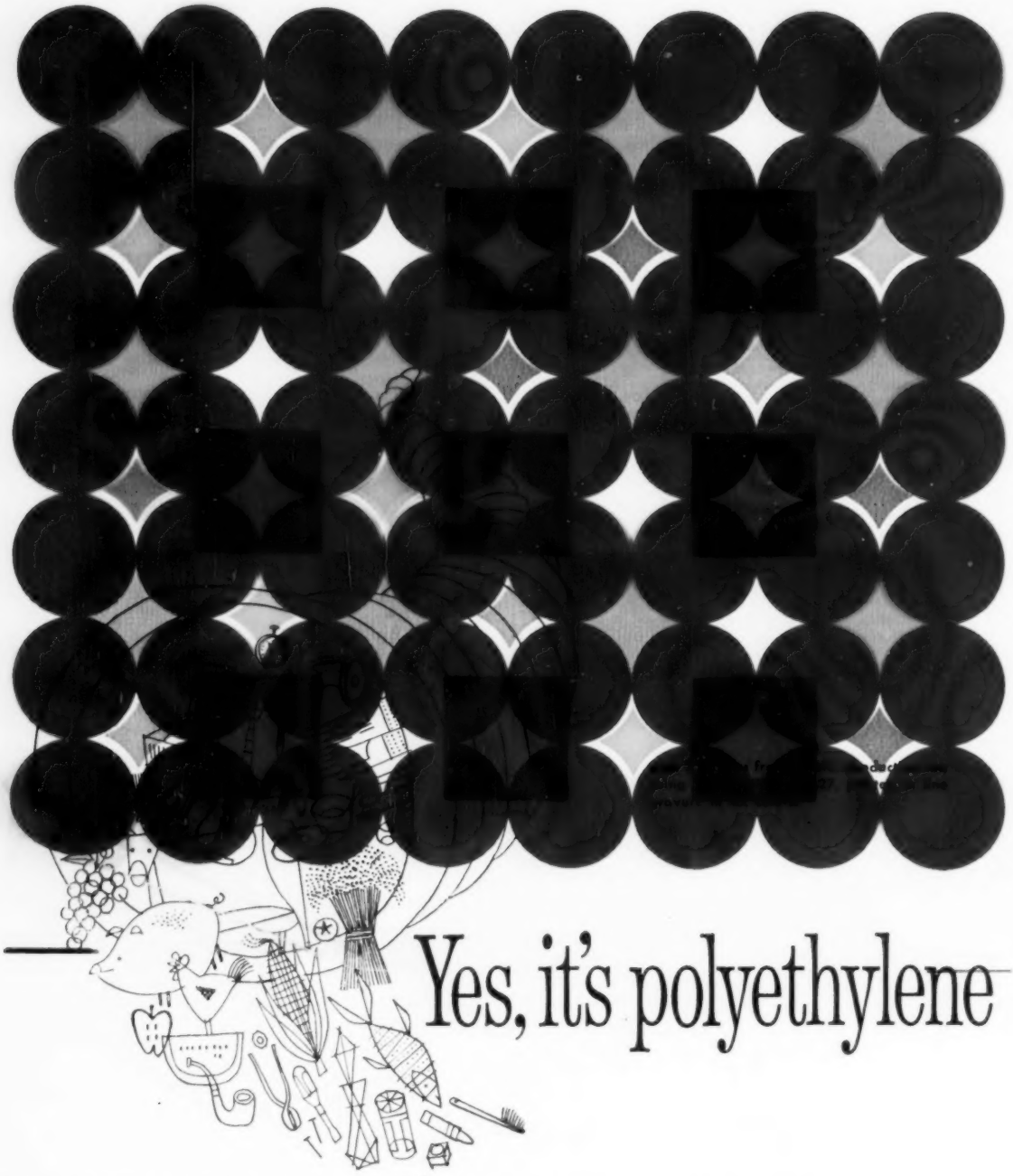
Cast polyethylene film will be demonstrated to the international market for the first time at the U.S.I. exhibit in the International Plastics Exhibition to be held in London, June 17-27.

Side-weld bags of ultra-clear PETROTHENE cast film will be made in the U.S.I. booth. Cast film was first introduced to the American market by U.S.I. last year.

In London, U.S.I. will also show packaging films made from PETROTHENE resins. A special feature of the exhibit will be a demonstration of how polyethylene garment bags are used by commercial dry cleaners to speed up customer identification of garments and to protect garments after they leave the cleaning establishment.

DO YOU HAVE a new polyethylene packaging development you'd like the industry to know about? Make it routine to send your information on new developments to U.S.I. POLYETHYLENE NEWS.

Address the Editor,
U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N.Y.



Yes, it's polyethylene

When you add brilliant printability to the clarity, toughness, and other well-known advantages of polyethylene, you can offer your customers a packaging material that will work as a powerful merchandising tool for their products. Polyethylene film can be economically printed with clear, bright colors at high speeds and with sharp registration and good ink adhesion. Packages can be formed on automatic machinery — sealed by heat-sealing or with adhesives.

Opens New Packaging Film Markets

With package designs that combine sparkling, multi-colored printing with polyethylene film's clarity, you can open up new packaging and merchandising opportunities for your customers. Printed film is now being used for dry-cleaner garment bags, produce packaging, soft goods overwrap, dairy and meat packaging, laundered shirt packaging, and many other applications where visibility, eye-catching color, and protection can be combined in a single package to give maximum sales appeal to the product.

In supplying film for this growing market, keep in mind the special advantages of U.S.I. PETROTHENE® polyethylene resins: excellent drawdown properties . . . superior toughness/clarity ratio in finished film . . . wide selection of resins ideally suited for clear or printed packaging film. Contact your nearest U.S.I. sales office for information.

U.S.I. is helping to expand your polyethylene film market with ads, similar to this one, addressed to the produce, food, dry-cleaning, and other package-using industries. These ads are designed to pre-sell <u>your</u> potential customers on the sales appeal and other advantages of polyethylene film packaging. To receive reprints of this advertising as it appears, write:

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N.Y.
Branches in principal cities

NEWS in BRIEF

Business developments in the plastics industry were varied in scope and nature. Atlas Powder moved its Thermaflow operations to its plant near Wilmington, Del. Borden Chemical transferred its government services dept. to its coatings and adhesives plant in Middlesex, N. J. Carbatex Chemical Co. changed its name to General Resin Corp. Chemore moved to larger quarters in New York City. Dobeckmun consolidated its activities with its parent firm, Dow Chemical. A plastic tool making dept. was set up by Durable Formed Products. Emery Industries moved its Chicago, Ill., office to new quarters. National Starch & Chemical Corp. is the new name for National Starch Products, Inc. Plax Corp. purchased U. S. and related worldwide patent rights for the fluorination of plastics from Shulton, Inc. A. E. Staley Mfg. Co. plans to enter the synthetic polymer field, and will acquire UBS Chemical Corp. F. J. Stokes Corp. took over production and marketing of Zimmerman Machinery's blow-molding equipment. Thoreson-McCosh appointed Plastic Molders Engineering as its Chicago, Ill., rep. Cutter Laboratories purchased all assets of Olympic Plastics Co. Gering Products has been purchased by Studebaker-Packard Corp., and will be operated as a division of the new owner. Capac Plastics has been purchased by Chicago Molded Products Corp. Allied Chemical bought Harmon Colors, a former part of B. F. Goodrich Co.

Company expansions in plastics continued in evidence this month. Carwin completed its second unit for the manufacture of isocyanates in North Haven, Conn. Continental Plastics plans to double the size of its new Oklahoma City plant. Dia-Chrome moved to new and larger quarters in Glendale, Calif. An expansion program that will add 5,000 square feet of lab space and experimental processing equipment has been started by Diamond Alkali in Painesville, O. Dow doubled the polyethylene capacities of its Freeport, Tex., plants and will build a new plant near Plaquemine, La. Goodyear has embarked on a multi-million dollar expansion program for vinyl flooring and counter tops. Hexcel Products is expanding its capacity for paper honeycomb materials in Berkeley, Calif. Koppers expects production this fall of expanded styrene panels in the newly-leased plant of the former Hudson Motor Car Co. in Detroit, Mich. Modiglass Fibers has added 10,000 square feet of manufacturing space to its facilities at Bremen, O. Riverside Plastics is adding more space for production and research to its existing plant in Hicksville, L. I., N. Y. Owens-Corning Fiberglas will relocate its research and product testing labs to new and larger quarters near Granville, O. Union Carbide Chemicals has doubled its capacity for producing polyether glycols in South Charleston, W. Va.

New Materials worthy of attention (see pages 65-6): modifier for PVC plastisols; amino-functional silane; textile-form graphite; silicone potting compound; alkylated phenol-formaldehyde resin; glass-polyester molding compound; multi-purpose epoxy resins; and sponge Teflon.

New Equipment of special interest (see pages 68-70): 6/9-oz. injection molding machine; high-speed sizing machine for cutting sheets; high-speed granulating and mixing machine; portable units for automatic metering and mixing of polyurethane foams; end-loading, automatic drum tumbler; and a series of portable tensile testing units.

Plastics Applications to be noted (see pages 73-7): molded acrylic suspensory clamps for power cables; vacuum cleaner with molded butyrate housing for swimming pools; removable, molded, high-density polyethylene tub for baby bassinets; polyethylene glove cabinet for manipulating radio-active materials and equipment; boat hulls of low-density syntactic core construction; slide viewer with molded housing of high-impact styrene; miniature connectors of molded nylon; large-size, cast acrylic blocks; golf clubs with phenolic-impregnated bamboo shafts; newly-designed housewares of molded, high-density polyethylene; PVC strainers for fluid-handling equipment; and light-weight, butyrate safety spectacles.

Cast 2-mil film from regular production run using PETROTHENE 239-27, printed in line gravure in six colors.

Yes, it's polyethylene

When you add brilliant printability to the clarity, toughness, and other well-known advantages of polyethylene, you can offer your customers a packaging material that will work as a powerful merchandising tool for their products. Polyethylene film can be economically printed with clear, bright colors at high speeds and with sharp registration and good ink adhesion. Packages can be formed on automatic machinery — sealed by heat-sealing or with adhesives.

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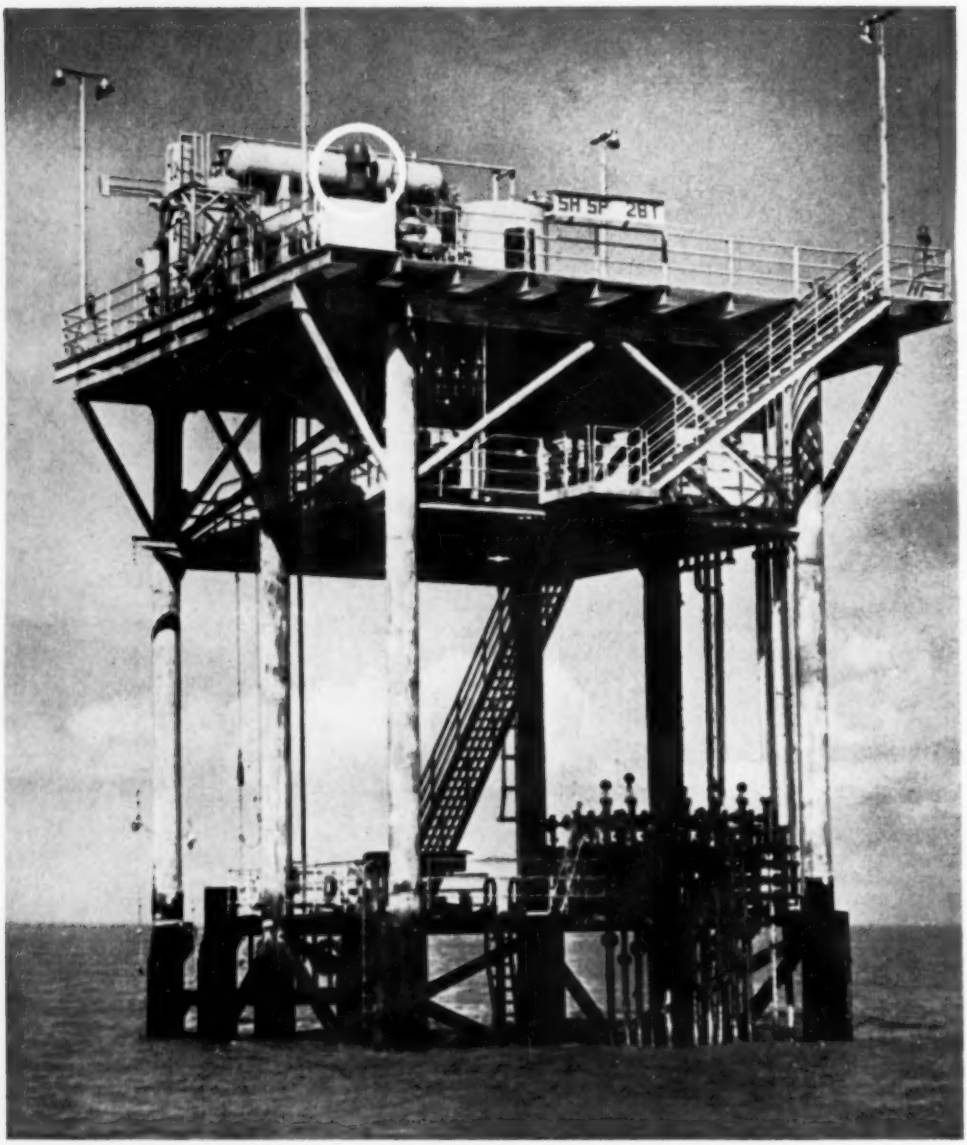
CYANAMID

CORROSIONEERING WITH REINFORCED LAMINAC® PLASTIC



Winner of an Award of Merit for design excellence at the 14th Annual Exhibit and Conference of the Reinforced Plastics Division, The Society of the Plastics Industry, Inc.

Four ft. tall and 17⅞ in. in diameter, the horn is produced by Wallace & Tiernan Inc., Belleville, N. J.

CAREFREE SENTINEL ON THE GULF OF MEXICO

The man-made oil drilling islands at the mouth of the Mississippi are under continuous corrosive attack by harsh marine atmospheres. So equipment must be made *impervious* to corrosion. The foghorn, for instance, that warns shipping of the presence of islands, like this Shell Oil Company, Delta Division, oil-drilling rig, is fabricated of rugged glass-reinforced LAMINAC® polyester resin. The reinforced LAMINAC foghorn is completely *corrosion resistant*, as well as resistant to impact. Weighing just 120 pounds, it can be lifted by one man. The previous metal horn required a crane to move it. *And the reinforced plastic horn requires no maintenance.*

CYANAMID

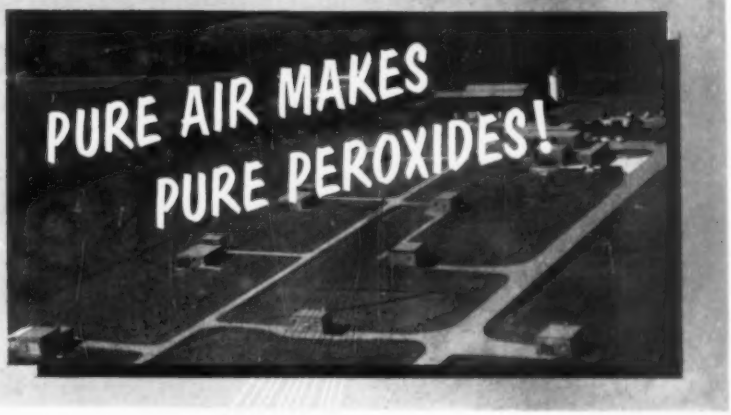
AMERICAN CYANAMID COMPANY

PLASTICS AND RESINS DIVISION

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Offices in: Boston • Charlotte • Chicago • Cincinnati • Cleveland Dallas • Detroit • Los Angeles • Minneapolis • New York • Oakland Philadelphia • St. Louis • Seattle

In Canada: Cyanamid of Canada Limited, Montreal and Toronto



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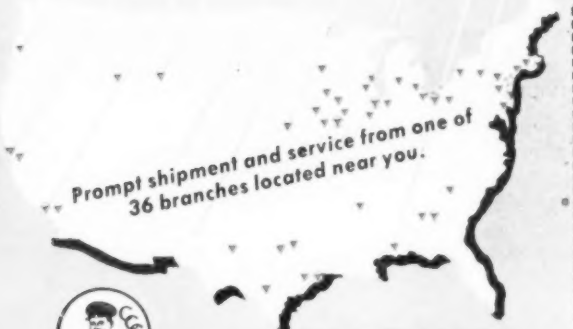

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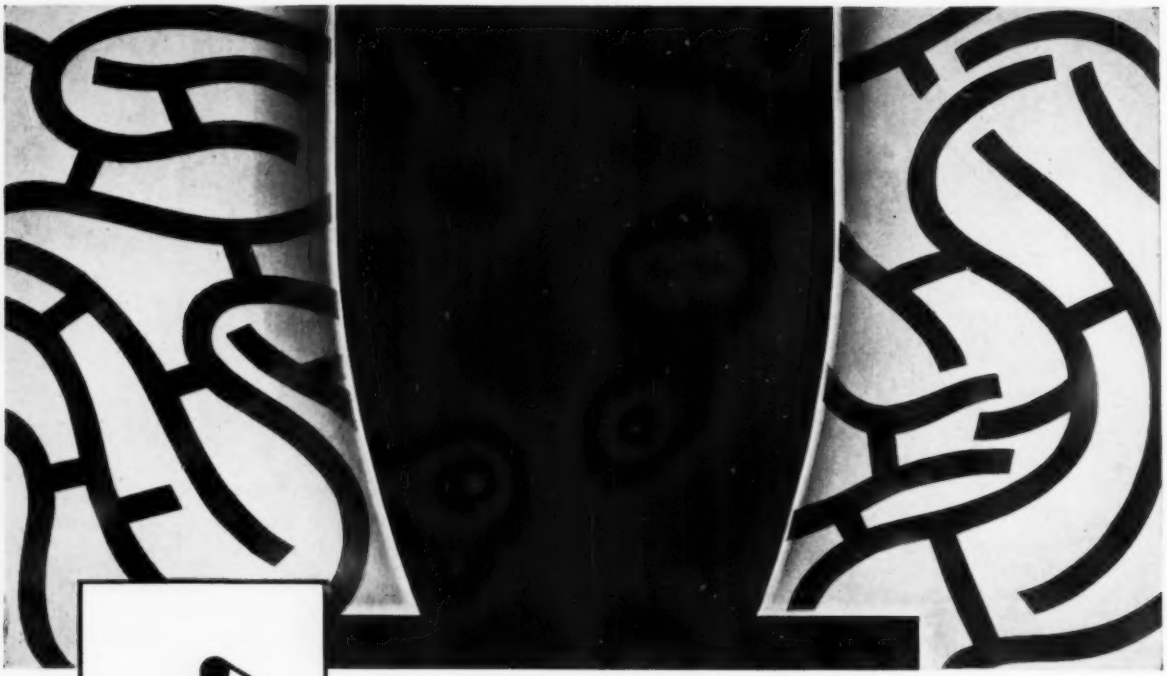

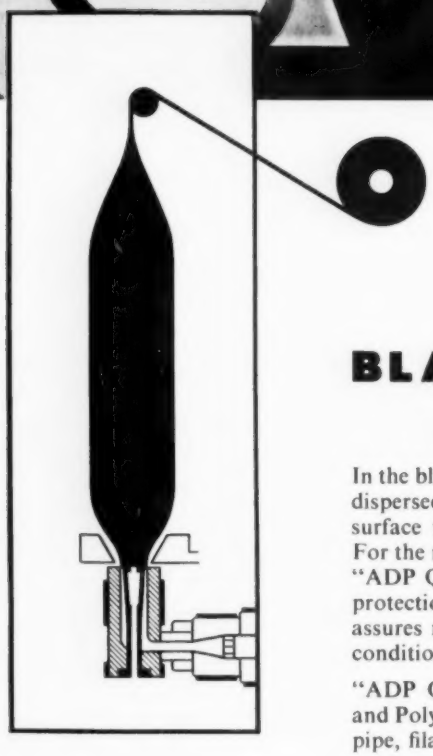

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Property	Value
Melt Index, g/10 min.	8
Density, g/cc at 23°C	0.935
Secant Modulus, psi	40,000
Tensile Strength, psi	1600
Elongation, %	210
Yield Strength, psi	1500
Brittle Temperature, °C	
50% OK	−70
80% OK	−60
Stress Cracking Resistance	
50% Failures, hours	>336
Mechanical Flex Life,	
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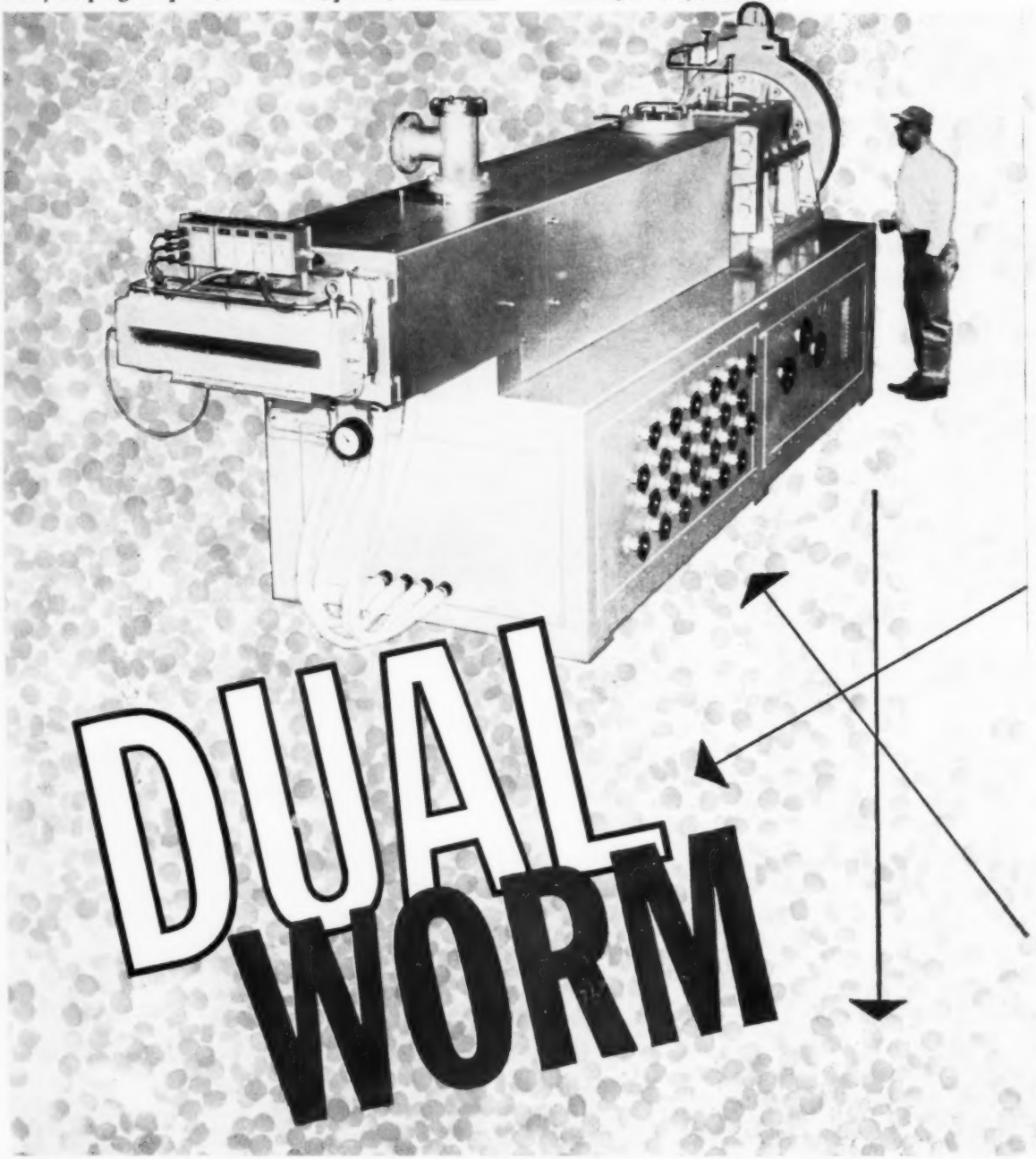

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Rigid Urethane Foams

A comprehensive review covering basic chemistry, formulations, preparation, chemical and physical properties, and applications.

DR. ANTOINE KHAWAM, *Tech. Director,*
Industrial Plastics Division,
The Englander Co., Baltimore, Md.

Author's Note:

This article is a review of rigid urethane foams up to date. It is based on a considerable number of patents and trade and technical publications, as well as the writer's personal experience and work. In order not to make it too complex, references have been omitted.

UNTIL the advent of urethane foams, the manufacturer of cellular plastics prepared the macromolecule in its final shape as needed in a particular field of application, and the user, in turn, was limited exclusively to physical manipulation and processing of the materials made available to him.

The urethane story is unique in that the processor is supplied with the reactive monomeric or partially-polymerized molecules, and he carries on the final polymerization reaction himself under the very precise conditions required. He starts with liquids and viscous liquid resins, and obtains the solid cellular material in the required shape. In this manner, he can tailor macromolecules to fit his exact and complex requirements (density, hardness, elasticity, insulating property, etc.) in a manner often impossible or exceedingly impractical by other methods. The reaction between isocyanates and polyols accomplishes this. Water or a volatile fluorocarbon is required to produce the cellular structure. The property of foaming-in-situ with excellent adhesion to most surfaces where foaming occurs makes urethane foams very outstanding; however, the chemical reactions are quite complex and the processor must learn how to select the ingredients and control the conditions to obtain the desired results.

Urethane Chemistry

The choice of a rigid urethane foam for a specific application depends on its properties which, in turn, are controlled by the molecular structure. These can be widely varied, as shown below, by the choice of starting materials and reaction conditions. Two factors influence the molecular structure; the degree of cross-linking, and the bond energy of the different linkages. Both are responsible for the intermolecular forces holding the polymeric chains together. Attempts have been made in recent years to correlate chemical structure and only the most important properties of simple polymers. Some qualitative data of significance is available, and will be used in an attempt to analyze and correlate polyurethane structure and properties. The eight, main

polar linkages constituting a urethane foam and contributing their own characteristics are formed, as follows:

(1). Urethane linkages from the addition reaction of the isocyanate group to an alcohol group. RNCO + R'OH⟶RNHCOOR
urethane

The reactive H in the urethane then reacts with another NCO group.

(2). Allophanic ester linkage from the reaction between the isocyanate group and the active hydrogen of the urethane linkage. RNCO + urethane⟶ RNHCONHCOOR'
allophanate

(3). Urea linkage from the reaction of the isocyanate group with water. RNCO + H_2O⟶[RNHCOOH] ⟶RNH_2 + CO_2 (CO_2 evolved is the blowing agent) RNH_2 + RNCO⟶RNHCONHR
urea.

The reactive H in the urea then reacts with another (NCO) group.

(4). Biuret linkage from the reaction between the isocyanate group and the active hydrogen of the urea linkage. RNCO + urea⟶RNHCONRCOR'
biuret

(5). Amid linkage from the reaction between the isocyanate group and a carboxy group. RNCO + R'COOH⟶RNHCOR' + CO_2 (CO_2 evolved is the
amide
blowing agent)

The reactive H in the amid linkage then reacts with another (NCO) group.

(6). Acylamide linkage from the reaction between the isocyanate group and the active hydrogen of the amide linkage. RNCO + amide⟶RNHCONRCOR'
acyl amide

(7). However, depending on the reaction rate, some ring linkages formed by the dimerization and trimerization of the reactive isocyanate group in presence of catalysts might be formed. This reaction is undesirable, and should be eliminated.

(8). The type of linkage in the reactive polyol is just as important (e.g., the polyester linkage in polyester-based foams, the polyether linkage in polyether-based foams, the silicone linkage, the phosphorus linkage, etc., present in special systems).

In cellular products, the above reactions proceed simultaneously. The amount of water, as well as COOH groups present, will determine the amount of the blow-in agent (CO_2) generated by the reaction. Recently, a new class of urethane rigid foams blown with a volatile fluorocarbon (e.g. Freon, Genetron, Isotron and Ucon) has been made available. These are made in the absence of water or (COOH) groups.

All these above-mentioned competing reactions proceed at different rates. These rates are controlled by several factors; e.g., reaction temperature, and the choice and concentration of catalyst. For a full understanding of the urethane reactions, it is necessary to know the relative rate with which each of the competing reactions proceed and how this rate is affected by the presence of specific catalysts. This study probably is being done by several laboratories, but little quantitative kinetic data are available up to the present time.

Antoine Khawam was born in Cairo, Egypt, in 1924. He attended Fordham University in New York City, receiving his B.S. in Chemistry in 1948; M.S. in Organic Chemistry in 1950; and Ph.D. in Organic Chemistry in 1953. In 1954-55, he acted as instructor and holder of a post-doctoral research grant at Seton Hall University. In 1955-1958, he was employed in the Isocyanate Applications Laboratory, Buffalo, N. Y., for the National Aniline Division of Allied Chemical Corp. In 1958, he went to Nopco Chemical Co., Plastics Division, North Arlington, N. J., as Group Leader. Late last year, he joined the Plastics Division of The Englander Co. as Technical Director, Research and Development, his current position.

Dr. Khawam is a member of A.C.S., S.P.I., and A.S.T.M., and his hobbies include fishing and playing the violin. He is unmarried, and lives in Baltimore, Md.

This is one of the most difficult problems in urethane that remains to be solved. Kinetics of the uncatalyzed reaction between a simple isocyanate and active hydrogens from each of the above-mentioned linkages were investigated by M. A. Deisz. When simple molecules were used, it was found that if the reaction rate of isocyanate plus urethane is taken as a standard and given the value of "1," the relative rates of the other reactions are as follows: urethane, 1; amide, 16; acid, 26; urea, 80; H_2O, 98; and primary (OH), 460.

It will be exceedingly difficult to investigate the relative rates under actual foaming conditions (viz., with the presence of catalyst and multifunctional macromolecules). However, in the absence of more information, the above data can serve as a guide in the selection of reactants and conditions. C. W. Bunn, of I.C.I., and others have done very outstanding work to evaluate the properties of various polar linkages. Of the data reported, the following are some general considerations made on simple systems. Therefore, since no work on the complex urethane, as such, was done, this data will be used to demonstrate possible differences in properties resulting from the final structures in the foams caused by different percentages of the linkages present.

POLYESTERS. A polyester of a certain chain length

melts at a temperature lower than does the corresponding polyamid of the same chain length. The melting point temperature decreases as the proportion of ester increases in a definite length.

POLYAMIDS. Melt at higher temperatures than do polyesters. In addition, those containing an even number of (CH_2-) groups between two amide linkages melt at higher temperatures than do those containing an odd number of these groups.

POLYURETHANES. Form higher melting point bonds like polyamids and give high cohesive energy, but since they contain the (-OCH_2-) linkage like the polyester types, they occupy an intermediate position between the above two types.

POLYUREAS. Have the highest melting point temperatures.

POLYETHERS. Introduction of an ether linkage (e.g., by the use of polyether glycols or epoxy resins as the source of (OH) groups in the foaming reactions) increases greatly the chain flexibility, resulting in decrease of melting point temperatures, while introduction of rings (aliphatic or especially aromatic) produces the opposite effect.

Another important factor is the spacing and presence of any side chains between the polar groups. As the length of the hydrocarbon chain increases, affinity for water decreases; e.g., neopentyl glycol polyesters were reported to give foams with lower water absorption properties, and foams from sebacic acid-based polyesters are superior to those from adipic acid. It also is well known that in polyether-based foams, polypropylene glycols give far superior foams than do polyethylene glycol types. This important property also is greatly affected by the nature of the linkage. Polyureas are known to have the highest moisture absorptions, while polyurethanes are the lowest with the polyamides in between. Hence, low-density foams which are practically free from urea linkage when blown with a fluorocarbon, will resist water better than do those blown with the CO_2 generated from the reaction between NCO plus water and containing a large percentage of urea.

Polyamids resist heat better than do polyurethanes which, in turn, are superior to polyureas. Silicones are outstanding in this effect; hence, a foam made from a polyol containing silicone will have a high heat-distortion temperature, as was reported in a British patent. The urea linkage imparts the greatest rigidity, while the polyurethane imparts the lowest and the polyamide lies in between. It follows that fluorocarbon-blown foams are less rigid and brittle than the corresponding CO_2-blown foams of the same density.

Due to the above-mentioned factors, the building blocks of the urethane foam molecule are governed by the following:

(1). Polyol. For rigid foams, low molecular-weight polyesters with a large number of active hydrogen (OH and COOH) per molecule and a high degree of cross-linking are necessary. It is beyond the scope of this article to discuss in any detail such a wide field with its limitless possibilities. In general, polyesters are made from such alcohols as trimethylol ethane, trimethylol propane or glycerol, and acids such as adipic, phthalic, sebacic, maleic, dimer acid, etc. Recently, polyethers with the proper molecular weight, degree of cross-linking, and number of reactive "H" per molecule have been made available. The properties to be obtained are determined chiefly by the formulation and choice of polyol.

(2). Polyisocyanates. For several reasons—reactivity, cost, ease of handling, and toxicity—TDI (tolylene diisocyanate in several isomeric mixtures) is the material of choice.

(3) Catalyst. The reaction rate is dependent on catalyst activation. Basic salts, tertiary amines, and acetylacetonate of metals of the eighth group in the Periodic Chart of the Elements commonly are used.

(4). Water. The amount of water determines the amount of (CO_2) evolved and, therefore, the density of the foam. It is very critical and should be measured with care.

(5). Surfactant. Foam formulations incorporate surfactants, which are very important in determining porosity, cell structure, and cell size. In CO_2-blown foams, non-ionic surfactants commonly are used satisfactorily. However, in fluorocarbon-blown foams, it is necessary to blend the "Freon" very thoroughly and rapidly into the reactive mass, and silicones are preferred.

(6). Plasticizer. These can be incorporated to impart desired properties.

(7). Dye, pigment. Foams can be dyed to any color.

(8). Filler. Inorganic fillers or fibers can be incorporated into the polyol premix to give certain desired characteristics.

(9). Flame Retardants. Flame retardants such as Sb_2O_3; Tris B-chloroethyl phosphate (Celluflex CEF) can be incorporated to make the foam self-snuffing.

Urethane Foams

Foam Formulations

The method commonly used at present involves the preparation of a quasi or partial prepolymer by reacting all the TDI needed for a particular formulation with part of the polyol under controlled conditions to give one package or component. The other component comprises the rest of the polyol and all the other ingredients. This method offers the following four outstanding advantages:

(1). The difference in viscosity between the two components is much smaller than if plain TDI is used and, therefore, blending and reaction are rapid.

(2). This partial reaction increases the degree of cross-linking.

(3). It allows the incorporation of functional groups impossible otherwise. For example, if a certain acid or polyol imparts certain desirable properties when formulated into the polyester, but gives a polyester of extremely high viscosity which is impossible to handle, the quasi prepolymer could be made from such a polyester with a workable viscosity, while the balance of the polyol in the formulation could be made from another polyol with workable viscosity (thus introducing partially the desired properties into the macromolecule).

(4). Due to the great ease of preparing the given

prepolymer, the one-shot system in the rigid series offers little advantage.

Foam Preparation

The two components previously described are metered and pumped (several pumping systems are available) very accurately to a mixing head. Here, they are mixed at high speed and the foaming mass poured into the mold or cavity to be filled. If spraying is desired, a two-component spray gun is used instead of the mixing head, and air is blown usually at 60-110 cubic feet per inch. As expected, every application requires specific conditions, reaction rates, etc., and these can be met by the proper selection of ingredients as previously outlined.

Figure 1 shows the machine presently being used at Englander's Industrial Plastics Division in making rigid urethane foam panels.

In batch operation, the two packages are poured into a container and mixed rapidly, using a fast motor or a hand drill equipped with an efficient mixer. The foaming mass then is poured into the cavity or mold.

Foam Properties

Two classes of properties should be discussed; resistance to chemical agents as well as to atmospheric conditions, and physical properties.

Chemical Properties

Urethane foams are unaffected by greases, fats and oils, as well as by aromatic, aliphatic, and chlorinated solvents. They are swollen, however, by prolonged contact with acetone and ethyl acetate. The resistance to air and ozone is excellent. Rigid urethane foams, unlike flexible types, discolor and yellow only very slightly in sunlight. This phenomenon is believed to be due to the action of ultra-violet on the isocyanate nucleus itself.

Contact with water at temperatures up to 125° F., even for long periods of time, is harmless. Under all conditions of usage, urethane foams are unaffected by mildew, fungi, and rot. They have no nutritive value, and are not attacked by rodents and insects. Heat resistance varies considerably with density and formulation. All foams have excellent resistance to low temperature (no shatter-in at -50° F.), while the resistance to high temperature varies from 200-325° F.

The ability of these foams to be dyed to any color by standard dyes and pigments is a significant chemical property. However, since the isocyanate reaction is exothermic, some heat develops particularly in the center of the foam which could cause a change in the shade. Heat-stable dyes and pigments, therefore, should be selected.

Physical Properties

DENSITY. The density can be varied from 1-70 pounds per cubic foot. Many factors control the density, as follows:

(1). Amount of H_2O and (COOH) groups in the polyol control the density in CO_2-blown foams, while percentage of fluorocarbon added or injected determines the density in the fluorocarbon-blown foams.

(2). Everything else being equal, the batch size and foaming temperature affect the density very appreciably; e.g., a certain standard foaming formulation gave a 1.5-pound density foam in a batch of 10-20 pounds; 1.75-1.90 pounds in batch of 1-2 pounds; and 2.75-3.0 pounds in batch of 100 grams at room temperature.

(3). Size and shape of the mold or recipient of the foam. The following study was made: Using 18-inch-square panels having thicknesses of 6, 3, 2½, 1½, and ½ inches in thickness, the test formulation which gave a density of 1.75 lb./cu. ft. in the first panel gave, respectively, densities of 2, 2¼, 3-3¼, and more than 4 lb./cu.ft. in the remaining panels.

(4). Foaming temperature and temperatures of the mold or substrate also affect the density.

STRENGTH. The strength of a foam is a function of the density, as well as the nature of the polyol used. A 2-pound density foam usually has a compression strength of 30 psi. at yield point (10-15% elongation), while foams of high density can be made with 1,000 psi. in compressive strength. Care must be taken to avoid brittleness due to excessive cross-linking. CO_2-blown foams are more brittle on account of the urea linkage than the corresponding fluorocarbon foams. Tables and graphs showing strength as a function of density commonly are available.

ADHESION. This is the outstanding characteristic of urethane foams, over the other so-called "foamed-in-situ" foams. They show excellent adhesion to most substrates (metals, glass, wood fabric, fiberglass laminates, masonite, all materials of construction, and most plastics). There exist a few exceptions which are used to great advantage; Teflon, silicone, and polyethylene greases and waxes. These, in turn, are used in molding applications as release agents. To meet unusual applications, the good adhesion can be improved still further by surface treatment with the same types of catalysts used in the isocyanate reactions or by certain complex organic salts of metals of the eighth group (such as ferric acetyl acetonate). Most panel applications require foams with densities in the neighborhood of two pounds per cubic foot.

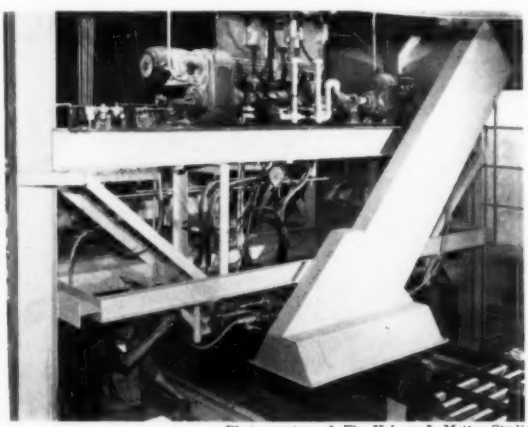

Photo courtesy of: The Holmes I. Mettee Studio

Fig. 1. Machine presently being used at Englander's Industrial Plastics Division to make rigid urethane foam panels.

Frequently, situations have resulted where the substrates broke loose during handling after the panel is removed from the mold. Actually, until fluorocarbon-blown foams appeared, CO_2-blown foams with a high percentage of urea linkages were so brittle on the periphery that the bond of foam-to-foam, being much weaker than the bond of foam-to-substrate, broke. This situation is avoided easily by heating the substrate and heat-curing the foam. In this manner, the friable layer is eliminated. The reaction exotherm is not dissipated equally in the foam, which is a perfect insulator, but tends to be confined to the center while the foam is rising, thus leaving a cooler outer periphery near the skin. This was proved by inserting copper constantan wires inside the foam at various depths. Fluorocarbon-blown foams having no urea linkage do not pass through the same brittleness stage before cure.

THERMAL INSULATION. The gas generated during the foaming reaction and intensified within the cellular structure results in very low thermal conductivity, making urethane foams among the best substances for thermal insulation. "K" values at 75° F. range from 0.20-0.30. In the density range of two pounds per cubic foot, the "K" value approaches 0.20, while in the range of 15 lbs. cu. ft. it approaches 0.30. Skin on the foam tends to lower the "K" value slightly, while heat increases it. Fluorocarbon-blown foams have a "K" value approaching that of the volatile fluorocarbon itself (0.13-0.14).

SOUND ABSORPTION. This depends greatly on cell size, elasticity, and porosity. Rigid foams can be made with a high percentage of open cells and improved sound absorption.

ELECTRIC PROPERTIES. The electric properties are good and cover a wide range which suggest certain formulations for specific uses. As a dielectric medium, the leakage generally is fair. However, the excellent permeability to X-rays and perfect radar transmission are very outstanding properties that place urethane foam in a privileged class with highly specialized usages.

VIBRATION AND SHOCK RESISTANCE. Resistance to shock and vibration is very good, making applications in vibrating bodies (trucks, airplanes, and trains) possible without detrimental effect.

FLAMMABILITY. Urethane foams cannot be ignited with a cigarette. When ignited with a flame, those based on polyesters, as well as on polyethers do burn.

Fig. 2. Floor, walls, ceiling, and doors of refrigerated Fruehauf Trailer are insulated with Ice-O-Lation panels filled with rigid Isolon urethane foam.

Photo courtesy of: The Holmes I. Mettee Studio

Fig. 3. Ice-O-Lation panels being installed in Fruehauf Trailer. Strips of vinyl-coated, flexible urethane foam are used to seal space between two panels.

However, the incorporation of various fire-retardant agents will make them self-snuffing. Fire-retardants must be selected carefully and the minimum additive used to produce the desired retardance, since they tend to cause some degree of shrinkage and distortion with aging. This is due to migration. Polyols can be made with built-in flame retardant groups and atoms.

MOISTURE ABSORPTION AND VAPOR TRANSMISSION. These are functions of cell size and structure. The absorption and transmissions of water in rigid foam with a high percentage of closed cells, especially those of high-density foams, is very small, and is reduced still further by the foam skin. As an added precaution and for long protection in unusual usages, an additional coating could be applied.

Applications

The unique properties of urethane foamed-in-situ, coupled with the most unusual combinations of properties outlined above and controlled by easily-selected structures, has suggested innumerable uses.

STRUCTURAL USES. Here is the greatest application for foaming-in-situ, sound and heat insulation, vibration and shock absorption, strength, and adhesion properties. Sandwich panels with light, strong urethane cores, are the materials of tomorrow. Soon, all sorts of cavities and the most complex interstices will be filled with such sealants in all phases of construction. Wide applications will be found in walls and ceilings of houses, offices, factories, and warehouses.

In transportation, various parts of the aileron, wing

(*Continued on page 50*)

R. E. ELY, *Research Engineer,*
Ordnance Missile Laboratories,
Army Rocket and Guided Missile Agency,
Redstone Arsenal, Huntsville, Ala.

Some Tensile Properties of Cellulose Acetate Butyrate

Test results are given for seven decades of tensile stress.

A range of specimen fracture times from a few milli-seconds to 1½ hours was obtained with the machines used. The instrumentation for the low-speed tests was conventional; i.e., pen recorders were used to record both load-time and load-elongation information. A transformer-type extensometer with a gage length of two inches also was employed at the lower speeds only. Elongation data at high speeds were reduced from motion picture records (1). Wire strain gage-type load cells were used for all speeds. Load-time curves for two high-speed tests are presented in Figure 1. The times to maximum load varied from 18.5-31.5 milli-seconds, and two different test temperatures are represented.

The test material was injection-molded cellulose acetate butyrate, Tenite 265A, MS. The specimen design (ASTM D638-49T) is designated PA-2. This design, however, was found to be unsatisfactory for tests below —76° F. since the fractures for these temperatures occurred outside the gage length. Specimens modified by machining the uniform section to a width of ¼-inch fractured satisfactorily; these specimens are designated PA-2¼". All specimens were dried according to ASTM Method D618-49T, Procedure B; that is, specimens were dried 48 hours at 122° F., and then stored in a desiccator.

Test temperatures ranging from —76 to +122° F. were maintained in the Instron conditioning cabinet by means of conventional heating and refrigeration equipment. The high-speed machine cabinet was conditioned by the introduction of air from the Instron cabinet; the lower limit for this procedure being —40° F. Tests at temperatures below —76° F. were limited to a cross-head speed of two inches per minute. These low temperatures were obtained by using a special liquid nitrogen cooler which enclosed the specimen and its grips (2)*.

Thermoplastics are being used increasingly for machine components and structural members. In order to design for such applications, the mechanical behavior of these materials must be known for both static and dynamic loads.

*Numbers in parentheses refer to Bibliography at end of article.

One approach to this problem is to obtain tensile properties for wide ranges of testing speed. Tensile tests at cross-head speeds ranging from relatively "static" values to several thousands inches per minute, however, are required to investigate viscoelastic behavior of these materials. In the present investigation, an Instron tester and a special high-speed machine are used to determine the tensile properties of cellulose acetate butyrate for seven decades of stress rate.

Test Method

The high-speed tensile machine, which is pneumatically operated, has been described previously in detail (1). The loading system is comprised of a piston and cylinder assembly, the piston being an integral part of the moving cross-head. Both sides of the piston are pressurized initially with gaseous nitrogen, and loading of the specimen is accomplished by exhausting gas from one side of the piston only. Speeds are controlled by suitable selection of exhaust orifice and initial pressure.

Test Results

The yield stress for the cellulose acetate butyrate varied from about 2,000-13,000 psi. for the extremes of test temperature and rate. This behavior (solid curves) as a function of the time-to-yield is presented in Figure 2. Time-to-yield values varied from about two milliseconds to 1,700 seconds. The time-to-fracture values varied similarly; at 74° F., for example, fracture times varied from four milli-seconds to slightly over 5,600 seconds. Each data point represents an average value for a minimum of three tests, and it should be stated that the yield stress values were accurately reproducible. All stress values are based on the original cross-sectional area of the specimens.

The dashed portion of the stress curves in Figure 2 indicate regions where the specimens fractured in a brittle manner before yielding was observed. These somewhat higher stress values, therefore, are maximum values and the corresponding times are the times-to-fracture.

In Figure 3, these same stress data and a tangent modulus curve for 74° F. (heavy-dashed curve) are presented as functions of the initial stress rate. The initial stress rate was determined from the initial slope of the individual load-time curves. The rate varied by a factor of 10^6 psi. per second. Strain rates at 74° F. were estimated by using the initial slope of the individual elongation-time curves. These strain rates varied from about 0.0036-1,800 inches per inch per minute, and the values appear directly above the appropriate data points on the 74° F. stress curves.

In Figures 2 and 3, it may be noted that the slope of the stress curves increases with increasing test speed, except where brittle fractures were encountered and the yield point was not reached. This behavior (i.e., increase of elastic response with increasing rate) is characteristic of many thermoplastics (3), and is attributed to exceeding the response time of the molecular structure that is associated with chain straightening and chain-chain slipping.

The increase of elastic response with increasing rate is also demonstrated by the tangent modulus curve at 74° F. in Figure 3. Beginning with six psi./sec., a value slightly less than 150,000 psi. was obtained. The modulus increases moderately with increasing rate up to about 1,000 psi./sec., and increases more rapidly to a value of 300,000 psi. at 750,000 psi./sec. This behavior indicates that there is a critical rate above which viscous response is curtailed. For this material, however, the critical rate is not sharply defined, but extends over a finite range.

The temperature dependence of the tangent moduli was investigated for two low speeds—0.02 and 2.0 inches per minute (see Figure 4). These moduli were determined directly from the initial slope of stress-strain (load-elongation) curves recorded with the X-Y recorder. These curves demonstrate that the elastic response of cellulose acetate butyrate is highly sensitive to temperature change. At 2.0 in./min., for example, the modulus increases from 150,000-400,000 psi. for a decrease in temperature of 198° F. (+122° to —76° F.).

Stress and specimen elongation curves for the Instron tests are presented also in Figure 4 as a function of the temperature. The elongation curves (data points omitted for clarity) show the total elongation of the specimens between grips at fracture. These curves demonstrate the ultimate strain trend for the butyrate.

The stress curves in Figure 4 represent several cross-head speeds. A similar set of curves could be plotted for the stress rates presented in Figure 3. It

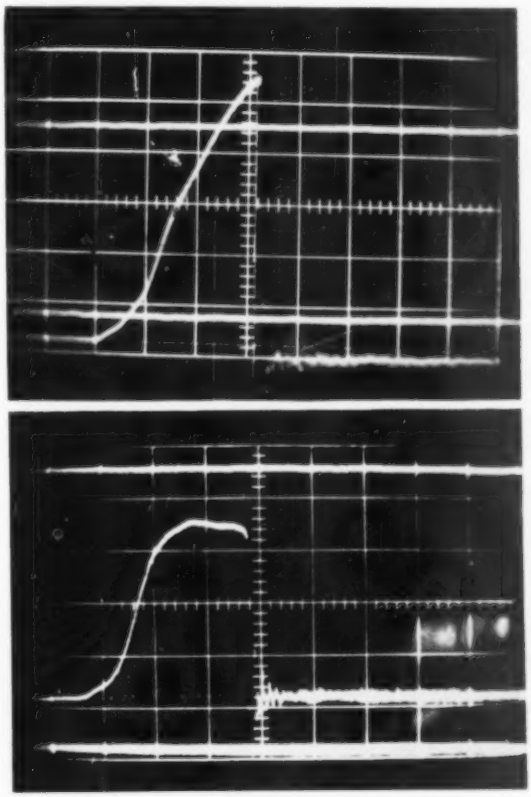

Fig. 1. Load-time records: (top) —40° F., 31.5 milli-seconds, 14,200 psi.; (bottom) 76° F., 18.5 milli-seconds, 6,420 psi.

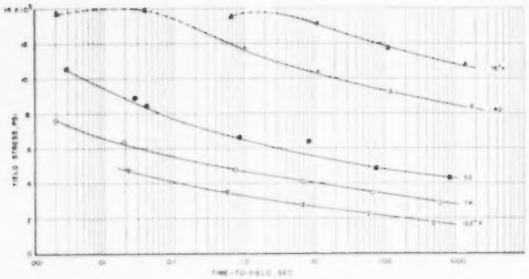

Fig. 2. Yield stress of cellulose acetate butyrate as a function of time-to-yield.

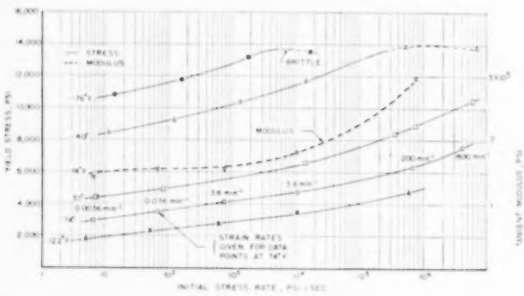

Fig. 3. Stress and modulus data for cellulose acetate butyrate.

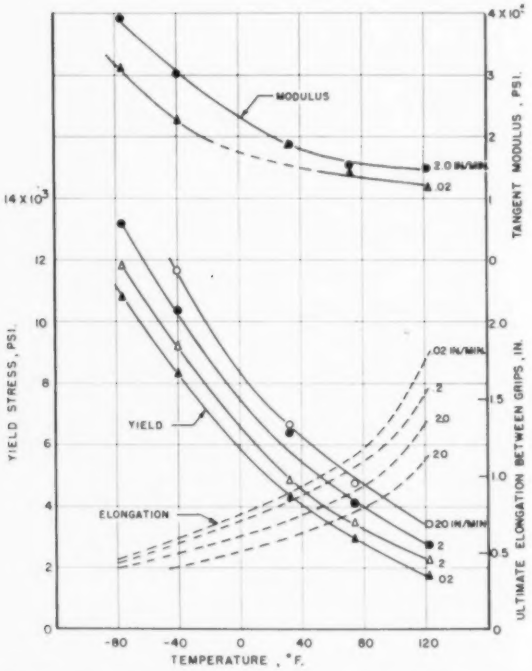

Fig. 4. Yield, elongation, and modulus data for cellulose acetate butyrate in terms of temperature.

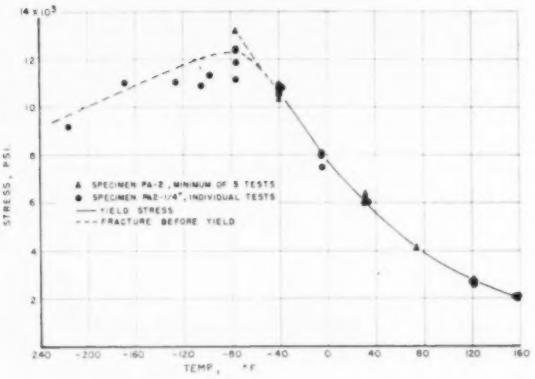

Fig. 5. Butyrate stress at testing speed of two inches/inch.

was found that such curves could be approximated closely (maximum errors of about 5% for a constant rate) by a formula of the following form:

$$YS = A\, e^{-BT}$$

This equation gives the yield stress as a function of the absolute temperature, T. The parameters A and B are functions of rate only, but are complex functions of this quantity.

Behavior of the material in the brittle region is not satisfactorily represented by a single exponential function. Figure 5 shows the brittle region and a maximum in the stress curve at extremely low temperature. Similar behavior was observed at higher rates and temperatures (see Figure 3). Stress values for the two specimen designs are in close agreement above —40° F. (see Figure 5). At —76° F., however, the modified specimens (PA-2¼") show somewhat lower stress values. These data (Figures 3 and 5) indicate that the stress curve at two inches per minute for the unmodified specimen probably would reach a maximum at about 14,000 psi. and —90° F.

Acknowledgment

Appreciation is expressed to the Plastics Research Laboratory, Picatinny Arsenal, Dover, N. J., which supplied the injection-molded tensile specimens.

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—THE END

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Selecting the Proper Marking Process for Plastics

A technique for proper selection of the marking process for thermoplastic products is presented.

SELECTION of the proper marking process and equipment should be left to the engineers or production men who are responsible for the end-results. It would be extremely helpful, therefore, to have a guide available which would aid them in making a wise selection.

Such a guide is not available from any source because the subject has never been researched nor presented in proper form for use by the technical men. The purpose of this article is to clarify and correlate some of the test results which were obtained while marking and decorating certain commonly-used plastics. This paper provides a handy reference for the benefit of those who must contend with plastics marking in sheet, rod, tube, molded or fabricated form.

Classification of Marking

Just as specific thermosets or thermoplastics are best suited to specific molding, extruding or fabricating jobs—so also is a specific marking process best suited to each of the various types of plastics used as well as the form of the end-product. There are so many different types of plastics that a simple formula covering all would require considerably more research than has been conducted to date. We can, therefore, merely give a chart for marking a few types (see Table 1), but it will prove quite revealing and generally applicable.

There are many qualifications to this charted information so you will need to read the following results of our experience not only to use the chart intelligently, but also to appreciate fully its value as well as the reasons for its limitations. We will pass over casein and melamines and use phenolics as an example of a specific thermoset which is used widely in the electronics industry and often requires marking.

PHENOLICS. This material includes paper-base impregnations widely used as electric terminal panels. These will hot-stamp nicely in a flat-bed press with temperature depending on the release factor of leaf or foil (about 350-450 F.). The die face can be relatively full

or not, as required by copy.

This group also includes fiberglass impregnations which are virtually impossible to stamp except under ideally-selected conditions of die lay-out, etc. Formica with a very dense, thin top layer of phenolic is practically impervious to hot stamping.

In printing phenolics, the same problems exist. The high gloss surface of a "Formica"-type certainly will not hold an ink. However, the relatively porous surface of the low-density, cut paper and canvas types impregnate with the mark and the ink holds through absorption by the minute pores.

Danger of Over-Simplification

Examples of the danger of over-simplification may be cited for many of the other groups of plastics. For example, polystyrene provides a tremendous range in properties (marking technique requirements) from the cheaper "reclaimed scrap" to the very elastomeric, high-impact types or modified acrylonitrile-styrene polymers.

Cellulosics (acetates-acetate butyrate mixes) actually are among the most difficult materials to hot-stamp, requiring exactly-prepared foil that changes properties with change in color. To illustrate this, we have an acetate job running at 450° F. on a roll method machine and an acetate-butyrate one running at 300° F. on a flat bed-type of machine. This demonstrates the wide variations that interfere with charting.

General Information

While there is some correlation of die temperature to the softening or melting point of plastic material being marked, there are other very important factors to be considered. To base a set of conclusions on this apparent correlation might prove very misleading. Too, other factors must be considered when hot stamping on card stock and paper.

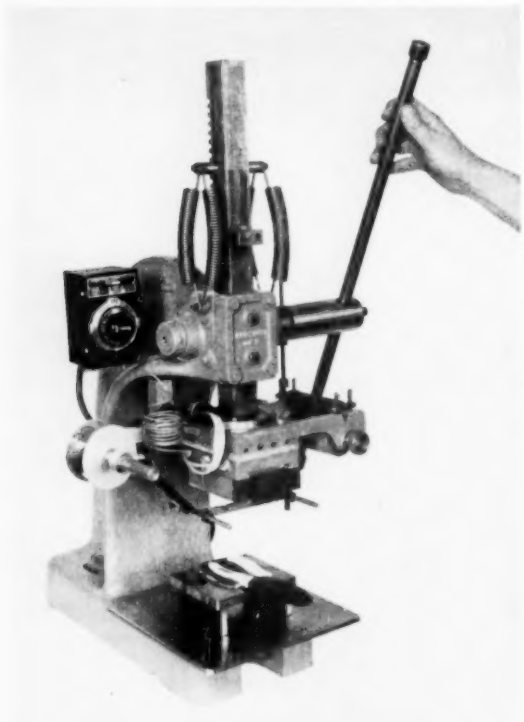


Fig. 1. Bench-model hot stamping press (Hercules No. 3).

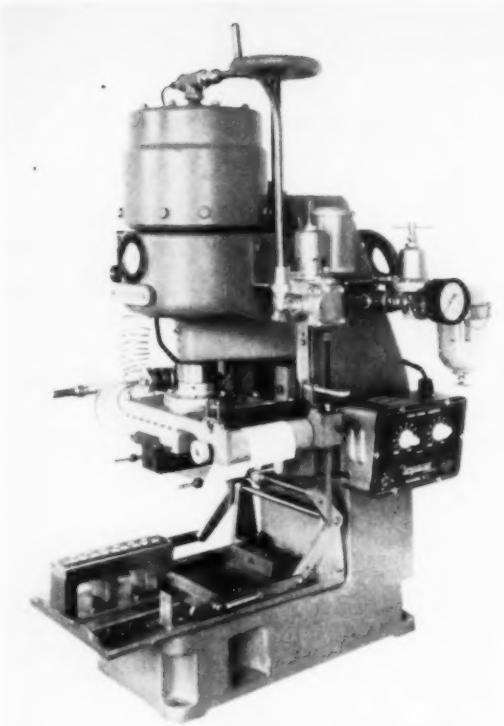


Fig. 2. Pneumatic hot-stamping press (Model No. 250).

The primary requirement is to use high enough heat so as to melt the resins in the specially formulated tape or foil, consolidate them with the pigment, and then pressure-fuse this softened mass into the pores of the paper. In support of this temperature versus melting-point correlation hypothesis, we can cite the example of hot stamping on lacquered card stock at fairly low temperature since the lacquers used generally have a low melting point. Substantially-higher temperatures are required for some acrylic coatings.

Any bonding to thermosets is actually a paradox by the temperature versus melting point hypothesis because there is virtually no softening of these materials after cure. Bonding, therefore, must be done by "brute force" or pressure and by some interaction or mechanical lacing of the resinous pigment to the microscopic porosity of the surface. This type phenomenon must explain stamping (bonding) on sulphuric-anodized aluminum where the surface has been modified so that it accepts the coloring dies and then is sealed by cold water. This surface certainly doesn't soften in the 250-350° F. range required to produce a bond. There appears to be no explanation other than that of mechanical bonding.

In the chart, we cite temperatures at which some jobs have been run. However, we believe that there

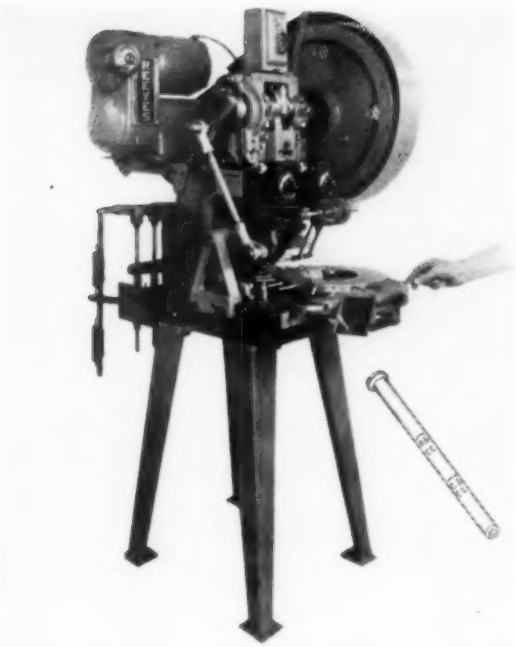


Fig. 3. Power hot stamping press (Acroleaf No. 2AH) marking nylon syringe parts. Spring arrangement at rear of machine acts as compensator to ensure perfect marking.

may be many others that, because of different factors, would not work anywhere near the temperatures indicated.

The Roll-Leaf Problem

Today, our tapes (Roll Leaf Foil) are manufactured to release from the carrier at about 325-375° F. This temperature range is selected on the basis of properties desired in the final mark: hardness, gloss or finish, top rub, cleanliness, and resistance to solvents.

It is impossible (or at least so impractical as not to be economic) to achieve all of these properties in a tape or foil and still have it release at a low temperature. In general, to lower the release temperature, the formula will be so loaded with plasticizer and wax or waxy derivatives that desired features of the mark or workability of the foil will be lost.

Marking Machines

The four basic types of hot-stamping machines are shown in Figures 1-4. In addition, a basic model printing machine with a wide range of general application is illustrated in Figure 5. Though the models shown are all Acromark units, each could be replaced by an equivalent unit made by some other manufacturer.

Rotary Hot Stamping

The Rotary "Point of Contact" Hot Stamping method is good in theory and ideal for many applications; however, there are certain instances where it falls short in practice. Two limitations of the method are reported as follows:

With rare exceptions, speeds generally must be slow in order to effect any "dwell." A specific pen-body job several years ago worked well by "press" (dwell 2-3 seconds), but could not be run on a rotary type

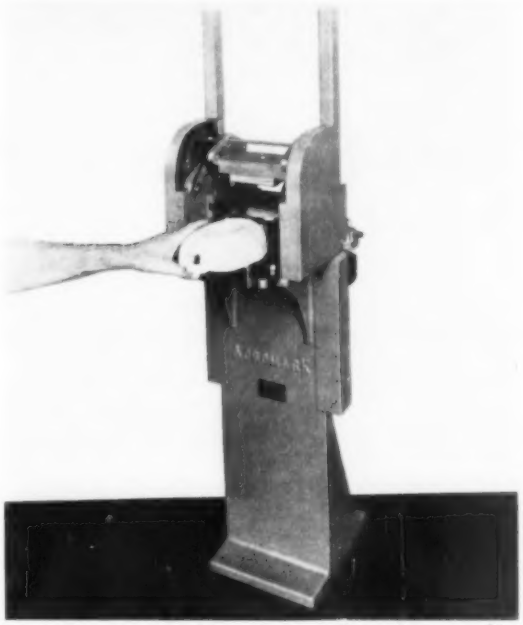


Fig. 5. Pneumatic ink platen plastic product printing machine (Acroprinter Model 401-A).

machine slow enough (commensurate with high production) to get reliable prints on the barrel. The material here was phenolic. Today's vastly improved stamping machine (Acroleaf or equivalent) will do the job, but there is still an occasional "speed" problem.

The second limitation relates to non-uniform die layout. Fortunately, 99% of our rotary stamping units (model 9AH or equivalent) are uniform and symmetrical, since the problem of compensating for the varying pressures required to roll on an unbalanced die area would be practically impossible to overcome. Because of "no dwell", rotary jobs generally must be run hotter than press jobs.

The above two paragraphs cover the two "minor"

(*Continued on page 50*)

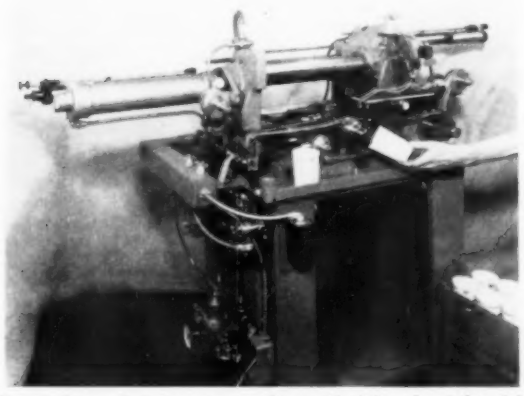
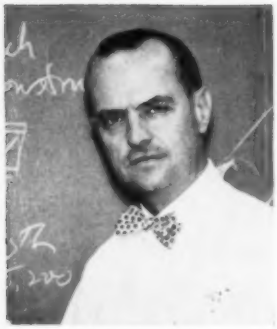


Fig. 4. Rotary hot stamping machine with sliding head (Model 9AH).



Arthur L. Smith

Factors Affecting Durability of Glass-Reinforced Polyester Plastics

How properties of polyester resins can be related to their performance in glass-reinforced plastics.

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WEBSTER defines "durability" as the "ability to endure or be lasting without wearing out," and continues, "Durability is the power to resist destructive agencies." The term destructive agencies can have many meanings, but for the purposes of this paper, we will be dealing with the destructive forces which result from out-door exposure; the sun's rays, wind, rain, hot and cold, or any and all combinations of these. The influence of these destructive forces on reinforced-plastic materials, particularly glass fiber-reinforced unsaturated polyester resins will be considered.

It appears that this subject is fairly narrow, but it is no less complex because of this. In fact, its complexity is magnified because we are dealing with a heterogeneous structure made up of two materials differing widely in their reactions to these destructive forces. During development work, this has required unusual care and analysis of data to be sure that we do not necessarily conform to previous concepts on behavior of materials, unless they satisfy the peculiar conditions dictated by this two-component, non-homogeneous system.

Thus, we must be mindful of the effects of these destructive forces on the resin itself, the glass fiber, and the attachment between the two.

Exposure Results

Before we consider how these various factors influence durability, let us review the results of outdoor exposure on some typical glass fiber-reinforced polyesters. In a previous paper (1),* the authors presented

* Numbers in parentheses refer to Bibliography at end of article.

information on conventional polyesters based on styrene compared with Paraplex P-444, a methyl methacrylate-modified polyester designed for maximum outdoor durability. These data were based on results of up to 36 months' exposure and showed unmistakable superiority for the P-444 composition. Additional time up to 44 months on some of these same exposed panels, as well as more exposures of similar compositions, continue to show outstanding superiority for the P-444 composition. Photographs have been taken of various exposed panels back-lighted to show light transmission. Figure 1 shows the result of 44 months' exposure at Bristol, Pa., of the following three resin compositions:

P-433/Styrene Polyester 60/Styrene 40
(A conventional light-stabilized resin)
P-446/Styrene Polyester 60/MMA**
10/Styrene 30
P-444/Styrene Polyester 60/MMA**
20/Styrene 20

Similar studies of P-444 (polyester/MMA—75/25) and P-433 (polyester/styrene—75/25) are both the concentrates without additional styrene dilution) showed that P-444/styrene is by far the best of the series, and markedly superior to P-433/styrene. As might be expected, P-446/styrene is about midway between. Furthermore, P-444/styrene was the only one that retains its original appearance and degree of transparency after about a four-year exposure. The others showed more or less evidence of erosion and fiber prominence. Data on gloss and color of the exposed samples are given in Table 1.

Another experiment was conducted, in which the monomer composition was varied in small increments. In a basic polyester composition of 60 parts polyester and 40 parts styrene, direct substitution of MMA for styrene was made at the following percentages of the total composition (0, 5, 10, 12.5, 15, 17.5, and 20) so that the final composition in the series was 60-polyester/20-MMA/20-styrene. Results of three years' exposure in Bristol, Pa., are shown in Figure 2. It is clear that durability, as evidenced by light transmission and fiber prominence, depends on MMA amount.

Results of 24-months' exposure in Florida showed the effects of different monomers. In addition to the usual back-lighted photograph, a photomicrograph also was taken to show surface degradation. According to the results obtained, it is clear that vinyl toluene is less durable than styrene. In the case of vinyl toluene, crazing is not so obvious because of the complete erosion of the crazed surface.

** MMA is methyl-methacrylate monomer.

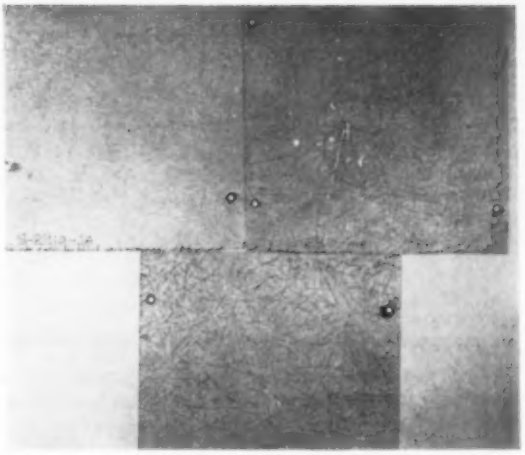


Fig. 1. Results after 44-Month Exposure at Bristol, Pa., for three glass fiber-reinforced polyester panels: (top left) P-444/styrene; (top right) P-446/styrene; and (bottom) P-433/styrene.

In order to relate this experimental work to commercial practice, a series of glass-reinforced panels were made up in clear, as well as in four different colors (white translucent, green, blue, and yellow), on plant-scale equipment. Exposed for 21 months, these panels compare P-444 and P-433 with commercially-prepared sheet made by a leading manufacturer and purchased on the open market. Results of back-lighted photographs in Figure 3 show differences, but do not portray fully the differences so readily visible in the actual samples. It is important to note the similarity of conventional P-433 sheet to the commercially-obtained sheet, and the improvement afforded by use of P-444. Note, particularly, the comparison of the exposed panel to the original unexposed control. In each case, the P-444 was unchanged from the control, while both P-433 and the commercial sheet show significant changes and deteriorations.

In another series selected from many experiments, comparison was made of three different commercial polyester resins. Each was diluted with 20% styrene before use, as is customary. To examine the effect of methyl methacrylate, each of these resins also was

Table I. Effect of 44-Month Exposure on Gloss and Color.

Name	Composition			Photo Volt Gloss#	Color,## A-B/G
	Polyester	MMA*	Styrene		
P444 Concentrate	75	25	—	16	0.103
P433 Concentrate	75	—	25	37	0.184
P444/styrene	60	20	20	81	0.196
P446/styrene	60	10	30	61	0.239
P433/styrene	60	0	40	34	0.244

* Methyl-methacrylate monomer.
# At 50° gloss, according to ASTM D-523-53T. High reading indicates good gloss.
Measured according to Federal Specification TT-P-141B, Method 613.1. Low reading indicates low degree of yellowing.

Table 2. Effect of 18-Month Exposure on Gloss and Color.

Composition	Color#		Gloss##	
	Control	Exposed	Control	Exposed
D/styrene	0.100	0.253	52	45
D/MMA	0.125	0.207	42	37
E/styrene	0.169	0.300	48	31
E/MMA	0.229	0.208	53	49
F/styrene	0.098	0.275	52	37
F/MMA	0.116	0.177	52	56

The lower the figure, the less is the degree of yellowing.
The higher the figure, the better is the gloss.

Table 3. Effect of 18-Month Exposure on Gloss and Color of Cast Polyesters.

Composition	Color#		Gloss##	
	Control	Exposed	Control	Exposed
D/styrene	0.049	0.209	98	49
D/MMA	0.047	0.159	92	81
E/styrene	0.136	0.288	98	69
E/MMA	0.175	0.127	96	86
F/styrene	0.048	0.278	95	77
F/MMA	0.063	0.134	95	87

The lower the figure, the less is the degree of yellowing.
The higher the figure, the better is the gloss.

diluted with 20% MMA. Exposure period was 18 months at Bristol, Pa. Photographs of the back-lighted panels are shown in Figure 4. Gloss meter readings and color determinations on these same sheets are given in Table 2.

Several points are worthy of special notice. In each case where the MMA was added to the commercial resin in place of styrene, improvement can be observed by the better color retention and lack of fiber prominence. Instrument readings of gloss and color (see Table 2) do not show this in all cases. Note that D/MMA has less gloss than D/styrene. These readings do not duplicate what is apparent to the eye because of the unevenness of the fiber-reinforced panel surface. This unevenness scatters the light reflected from the surface, instead of having it register in the photovolt meter. In Table 3, however, where measurements were made on cast resin samples, truer and more uniform results were obtained. This points to the need for extreme care in obtaining instrument measurements from heterogeneous materials such as glass-reinforced polyesters.

Table 4. Coefficients of Linear Thermal Expansion, x 10^{-5}/°C.

Temperature, °C.	Resin D	Resin G	"E" Glass	Acrylic
−20	5.2	7.2	—	6.0
0	5.4	8.5	—	7.0
+20	6.0	10.1	0.5	8.1
+40	8.0	12.6	—	9.3

Accelerated Tests

All results reported in this paper are based on actual outdoor exposures at either Bristol, Pa., or Miami, Fla. The accelerated tests found most useful in guiding early experimental work are Fadeometer and Weatherometer test methods. The Fadeometer test is one which our laboratories found good only for initial screening of resistance to ultra-violet light. It no longer

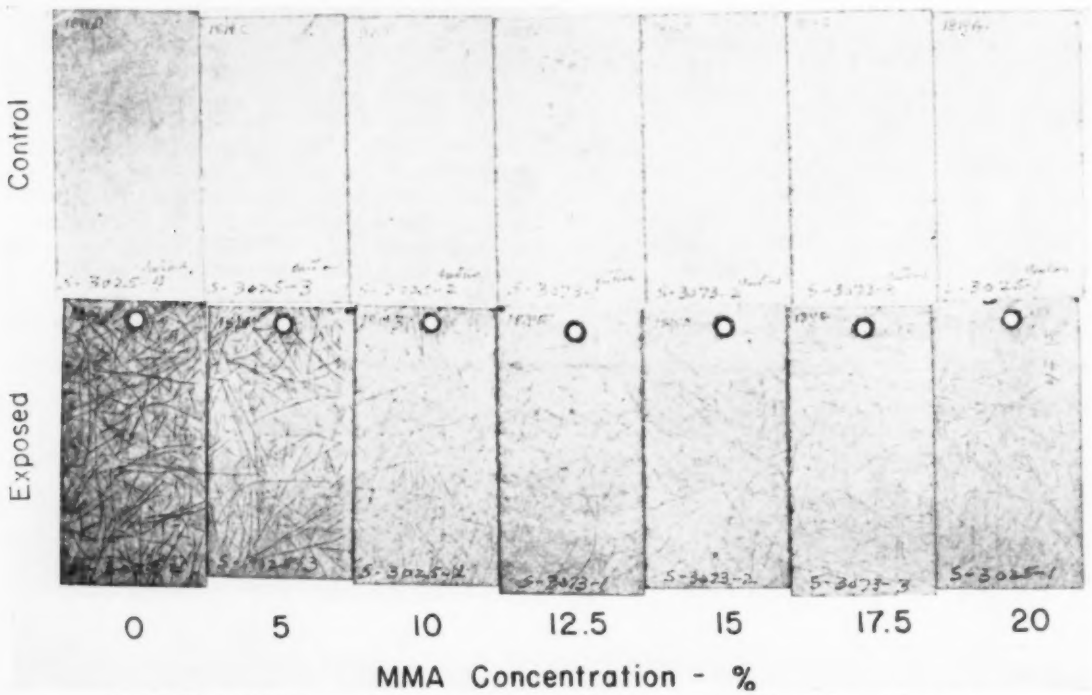


Fig. 2. Effect of MMA concentration on polyester panels exposed for 36 months outdoors at Bristol, Pa.

is used because, though rapid, it is reliable only for detecting large differences. The Weatherometer (ASTM E42-55T) gives more reliable, accelerated test information. It gives results not only on discoloration, but also on resistance to degradation by erosion. However, much care must be used in interpreting results, and results can be grossly misleading unless all test conditions are strictly adhered to.

Polymer Durability

What causes materials to degrade and fail in outdoor exposure? Not all do, and some withstand the ravages of these destructive elements (sun's rays, wind, rain, heat and cold). Why?

It is not within the scope of this paper to discuss all phases of the destructive forces, but we do want to deal with a few of them which are relevant to problems facing us with glass-reinforced plastics. Of all the destructive agencies, the sun has the most profound influence on the durability of the polyester itself. A normal polyester can be subjected to all other elements or combinations of same without serious degradation. However, the sun's radiation, particularly the ultraviolet range, is known to be damaging to polymers, as evidenced by color development and polymer breakdown (2, 3, 4).

The variables in a polyester which contribute to durability are chemical composition, molecular weight, type and proportion of monomer, and cure. All have an influence on the resin's performance. Our work has shown that this third point (type and proportion of monomer) is most important and has not received enough attention.

The relatively poor outdoor durability of the thermoplastic (polystyrene), as well as the exceptionally good durability of polymethyl-methacrylate, are well recognized. This suggests that the styrene-styrene bond is not stable to outdoor weathering. Thus, it is not too surprising that conventional polyester/styrene resins, which, according to stoichiometric calculations have styrene-styrene linkages, show signs of degradation as early as one year after exposure. However, these conventional polyester/styrene resins are distinctly superior to polystyrene, suggesting that the polyester itself is durable. In the case of polymethyl-methacrylate, there is no question that the polymer itself is excellent in durability.

Reasoning further, it might be expected that a polyester/methyl-methacrylate composition would be durable, but this is not so. The apparent reason for this is that polyesters and MMA do not copolymerize

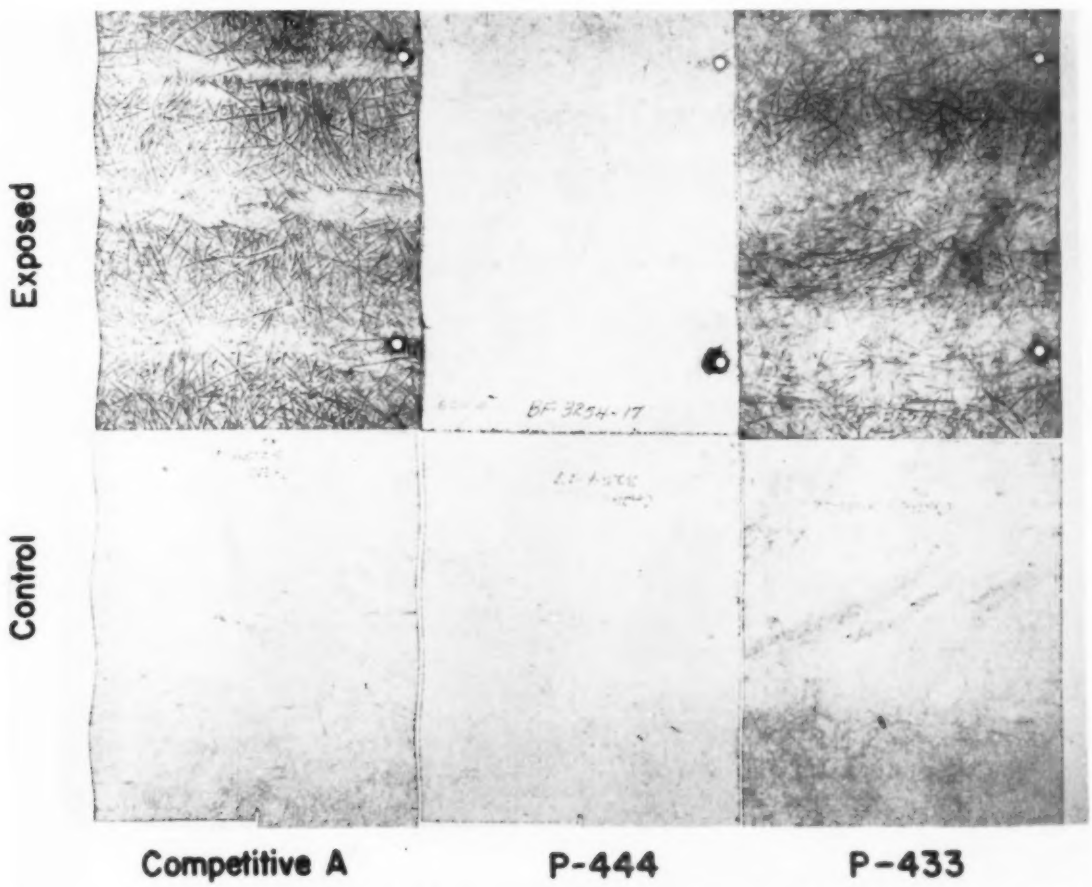


Fig. 3. Control and test panels after 21-month outdoor exposure in Bristol, Pa., of three glass-reinforced, clear, corrugated sheets.

readily and, therefore, give a composition in which some polyester remains unreacted in a mixture of polymethyl-methacrylate and some loosely-formed polyester/MMA copolymer. This incomplete copolymer is not stable to outdoor exposure.

If, however, we can provide a bridge between the polyester and the MMA to aid in their proper copolymerization, we should expect substantial improvement. Styrene itself fulfills this function admirably, since it copolymerizes readily with both MMA and with fumaric unsaturation in polyesters (5).

If the styrene ratio is such that we could anticipate no styrene-styrene bonds, the durability should be improved drastically and should approach that of polyMMA. It is seen in Figures 1 and 2 that although improvement is afforded by the use of some MMA, the best results are derived from an equal ratio of styrene/MMA. Extensive experimental work has shown that this is the optimum ratio for best results. These data confirm the above reasoning.

Relative to the influence of polyester composition on durability. There are too many factors involved to deal with this subject adequately in this paper. It is sufficient to report that considerable differences can result from varying components of the polyester resin. Selection of base polyesters for exterior use have been made on the basis of performance. The influence of polyester composition on physical and chemical properties which bear on outdoor performance will be discussed later in this paper.

Molecular weight of a polyester must be sufficient to assure a minimum of water-susceptible end-groups consistent with other properties of the resin. It is obvious that water-susceptible terminal carboxy or hydroxy groups detract from durability. The higher the molecular weight of the polyester resin, the fewer of these end-groups there are, and the better the durability.

Cure also must be complete in order to assure good exterior performance. Studies are currently in progress to investigate the influence of cure-time on polyester durability. Results are not yet complete, but preliminary indications point to the importance of elevated temperature in attaining adequate cure in a reasonable length of time.

Continuing our consideration of those factors which influence durability, we will mention only the glass itself. The composition of the glass and its susceptibility to moisture certainly will have a bearing on durability and performance. "E"-glass selected for use in reinforced plastics has excellent resistance to water and chemicals (6).

Composite Durability

Let us now examine those factors which influence the outdoor performance of the end-product, the composite glass fiber/polyester panel. These factors are glass properties, resin properties, attachment between resin and glass, and geometry of the construction. There are three main types of deterioration in the heterogeneous combination of polyester with glass fiber; discoloration, erosion, and fiber prominence.

Discoloration of any colored glass-reinforced panel is due to the stability of the color used, the yellowing tendency of the resin itself, and the type of ultra-violet light stabilizer used (7). Other factors can influence yellowing, such as the type of catalyst—in general, acyl peroxides (such as benzoyl peroxide) are best; and the type of accelerator (amines generally are bad, particularly dimethyl aniline). Thiols and soluble metals have some yellowing tendency; quaternary ammonium salts are best. Since this paper is concerned primarily with the influence of resin on discoloration, we will limit our remarks to those already made in earlier sections of this paper.

Discussion of erosion and fiber prominence have been neglected somewhat to date. However, these defects certainly need attention. A mechanism has been postulated to explain this improved performance on the part of the resin. It can be seen from Figure 1, however, that fiber prominence as well as erosion resistance and gloss retention have been improved. The question then is what causes fiber prominence?

Examination under the microscope reveals that the

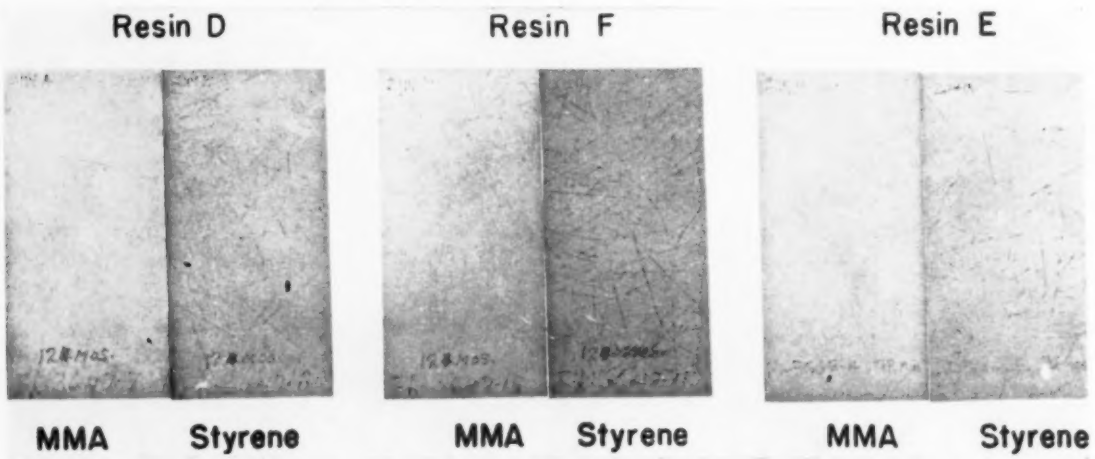


Fig. 4. Comparison of MMA and styrene as diluents for three different compositions of glass-reinforced polyester panels after 12-month exposure in Florida.

attachment which originally existed between resin and glass fiber has been destroyed, producing a void. This void reflects some of the light instead of transmitting it, causing an opaque appearance or "prominent fiber." Most of this fiber prominence appears on the exposed surface of the sheet, but sometimes on the underside and even in the interior of the panel.

Some of this fiber prominence can be attributed to erosion of the polyester from the face of the panel, but not all of it. In Figure 5, for example, Resin G/styrene is much worse than Resin D/styrene. However, when tested as a cast polymer, Resin G/styrene is superior to Resin D/styrene in gloss retention and durability. Why, then, is Resin G inferior to Resin D in glass-reinforced structures? Examination by microscope reveals that thin pieces of resin have broken away from the surface of the sheet where they previously covered the glass fiber. This suggests that it is not solely erosion of the resin per se, but rather a microscopic rupture.

Careful further analysis suggested that this resin failure was due to a type of stress fatigue. These stresses are caused primarily by two factors; (1). difference in coefficient of linear thermal expansion of the resin versus the glass, and (2). water absorption and consequent dimensional change in the resin. Table 4 lists coefficients of linear thermal expansion of several different resins, as well as that of "E" glass.

Considering these data, it is clear that Resin G, which shows roughly a 50% greater thermal coefficient than Resin D, would have greater stresses at the glass-resin interface on heat-and-cold cycling of the glass-reinforced polyester composite. This factor undoubtedly contributes to the greater fiber prominence exhibited by Resin G as compared to Resin D in Figure 5. Similarly, it contributes to the greater fiber prominence observed in reinforced-acrylic syrup versus P-444/styrene.

Difference in moisture absorption characteristics, with corresponding differences in dimensional change with moisture, also influences stresses at the resin/glass interface. Not only is there a difference in absolute gain of moisture, but also rate for gain of moisture which is important since it is not difficult to conceive that when dew settles on a panel, followed by evaporation in the early-morning sun, the resin is subjected to a short-time soak. Recognizing that this rate of moisture absorption, rather than an equilibrium moisture-gain as is measured by most water absorption tests might well be the more important factor, a test was devised and run on several resins.

The standard ASTM water resistance test was conducted (Method D570-42), except that specimens were weighed at short intervals during the initial period of immersion. Results are given in Figure 6. As anticipated, these data show that there is considerable difference in rate of moisture gain. Assuming equivalent moduli of elasticity for all the resins and noting that change in dimensions (or strain) is proportional to change in weight, a faster rate of gain in weight should result in a faster rate of stress in the polymer and at the glass/resin interface. In other words, stress is proportional to gain in weight at any given time.

Figures 5 and 6 show results which confirm this concept. Note that Resin G, which gained moisture at the fastest rate, is poorest in fiber prominence. It follows, according to these data, that the fiber prominence should be from worst to best in the following order: Resin G>P-44/MMA>P-433/styrene>P-444/styrene. Examination of Figues 1 and 5 reveals agreement with this prediction, except that the acryiic syrup is somewhat better than P-443/styrene. This emphasizes the need for consideration of all factors.

The lack of polymer durability of P-433/styrene renders it poorer in performance than the acrylic syrup. However, comparing polymer systems of the same order of durability in the polymer form (P-444/styrene and acrylic syrup), the stress fatigue factor from moisture gain and loss does explain why the P-444/styrene is superior to acrylic syrup in glass-reinforced construction.

Figure 7 shows photomicrographs of control, one-, and two-year exposed glass-reinforced panels made with resins D, F, and P-444/styrene. Controls, of

Fig. 5. Comparison of results obtained with three different resin combination in glass-reinforced polyester panels exposed for 12 months in Florida.

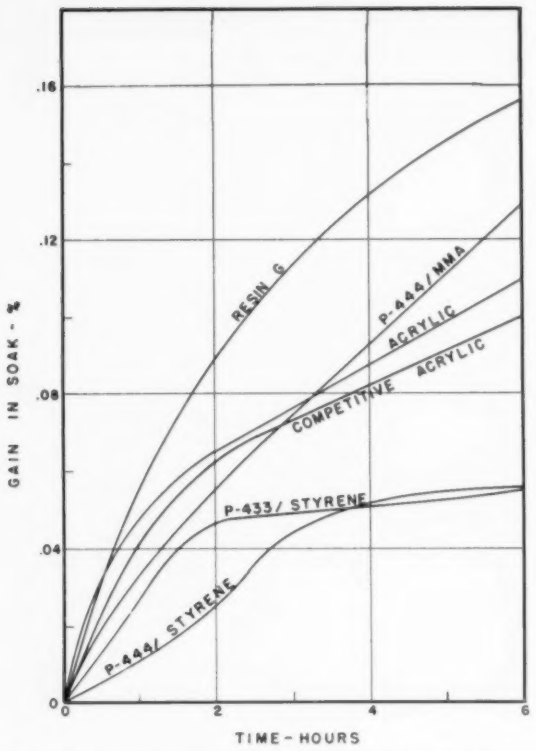


Fig. 6. Results of short-time, water-absorption tests at 23° C. on various types of cast polyester sheets.

course, show no evidence of fiber prominence or crazing. One- and two-year exposures show moderate and severe crazing, respectively. P-444 styrene shows no crazing. Although some of this crazing is due to the stress fatigue factor, resins D and F (being conventional styrene polyesters) are not very durable of themselves. Some crazing has resulted from this.

However, crazing is apparent on glass-reinforced acrylic syrup panels after 42-months' exposure at Bristol, Pa. On these panels, the glass fibers have become prominent. Microscopic study of these panels (see Figure 8) show the type of failure which has occurred. The polymer has crazed around the glass fibers where the stresses have been caused by expansion

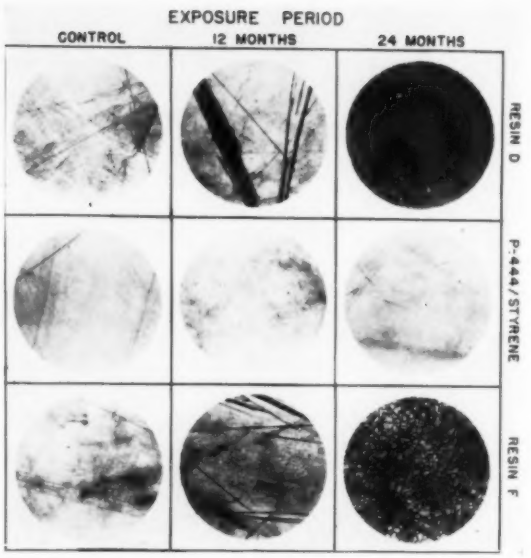


Fig. 7. Photomicrographs of results obtained with various resins in glass-reinforced panels exposed to Florida solarization.

and contraction of the polymer due to temperature and, in particular, moisture changes. This condition has resulted in a type of stress-fatigue failure of the polymer. In the case of P-444 styrene, no crazing or failure has been observed because of its superior moisture-resistant properties and resistance to stress-crazing.

No particular mention has been made of resin/glass attachment. Needless to say, this is most important in order to minimize fiber prominence and maintain physical properties.

The other factor contributing to panel durability is the actual cross-section geometry of the panel. For maximum durability, it is best to have a uniform resin overlay on top of the glass fibers. Not only does this provide a heavier protective coating of resin over the fiber, but also it reduces the surface stresses (and crazing) due to absence of glass in the extreme outer surface.

This type of overlay can be accomplished by several means, as follows:

(*Continued on page 50*)

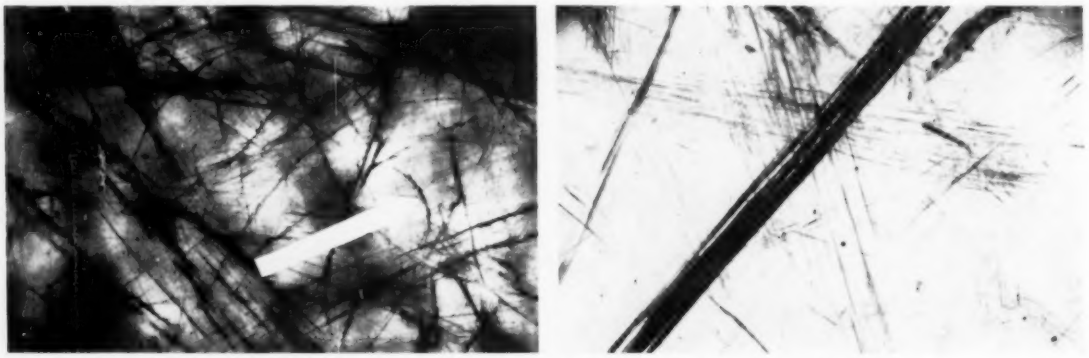


Fig. 8. Microscopic results (10X) of glass-reinforced sheets exposed for 42 months in Bristol, Pa. Panels were made from (left) acrylic syrup, and (right) P-444/styrene.

Guest Editorial

Photo courtesy of Underwriters' Laboratories, Inc.

G. H. POPE, *Managing Engr., Casualty & Automotive Dept., Underwriters' Laboratories, Inc. Chicago, Ill.*

Clarifying U.L.'s Position on Plastics in Air-Conditioners

Editor's Note:

On January 14, Underwriters' Laboratories issued Bulletin 484 which dealt with a Test Procedure for Evaluating Plastic Materials Used in Room Air Conditioners. Broadly speaking, this apparently limited the use of plastics in these units to "self-extinguishing or better" types. The resulting uproar and confusion in the plastics materials field, and also between manufacturers of air-conditioners, led to various conferences between industry groups and U. L. representatives where interpretations and clarifications were obtained. The "last word" on this situation is presented in this Guest Editorial.

THE proposed requirements on air-conditioning equipment apparently have been widely interpreted as a move on the part of Underwriters' Laboratories, to eliminate the use of slow-burning plastics in listed equipment. This was not the intent, and this Guest Editorial is an effort to place the proposals in proper perspective.

Underwriters' Laboratories is concerned solely with the hazard of materials as used in equipment, regardless of the materials. Any manufacturer of air-conditioning equipment who wants to submit same for investigation with a view towards listing, is privileged to propose any materials he sees fit, and those materials will be judged by the Laboratories on the basis of the aforementioned fundamental policy. If, however, the manufacturer is planning to substitute combustible material in equipment where non-combustible material was used previously, it would be desirable to submit this equipment in preliminary form prior to tooling for production, in order to avoid expensive changes should changes be found necessary.

With specific reference to the proposed requirements, it is pointed out that some new model air-conditioners were submitted for investigation and comments were made on features of construction that needed changing before listing could be extended. These comments related to the use of slow burning plastics, and the manufacturers suggested that it would be helpful if the industry were provided with guidance on the use of the materials to indicate constructions that might be accepted without the necessity for further investigation. It was in this spirit that the situation was discussed in

(Continued on page 53)

Rigid Urethane Foams

(*Continued from page 33*)

tips, and rudders of aircrafts have a urethane core. Recently, the propeller blades of the L-1049 Super Constellation of KLM Royal Dutch Airlines were filled with a urethane foam. In refrigerated trucks and cars and in passenger trains, urethane foams can solve many problems. In buses and automobiles, several parts such as heater core and body can be and, to a certain degree, have been insulated with urethane foam. Some automobile manufacturers initiated their uses in the 1957 models.

Figure 2 shows a refrigerated trailer constructed of "Ice-O-Lation" panels filled with rigid "Isolon" (urethane foam) developed and engineered by The Englander Company. Figure 3 shows how the entire unit is assembled. This figure also shows how strips of vinyl-coated, flexible urethane foams are used to seal tightly the space between two panels in the trailer assembly.

THERMAL AND SOUND INSULATION USES. Such uses cover wide installations on sundry equipment, pipes, ducts, refrigerators, air-conditioning units, water coolers, freezers, accoustical equipment, engine cowlings, and containers for the shipment of delicate, expensive items. Sound insulation can be improved by covering the foam mold with fleece or fibers, resulting in a heavier density on the outside. This is known as the flocking process.

ELECTRICAL AND ELECTRONIC USES. Such applications as the following are being investigated actively:

(a). Encapsulation of entire electronic equipment such as transformers, coils, condensers, and wire as protection against vibration and shock;

(b). Radomes for various applications; and

(c). Insulation, bonding, and fillings in guided missiles.

BUOYANT USES. Many applications make use of this outstanding property in addition to the classical properties. These include the following:

(a). Life rafts and preservers;

(b). Small boats;

(c). Fishing and other types of floats;

(d). Pontoons—a few years ago a large-scale experiment was carried on by the French Army on the Rhine, when more than 100 pontoons were filled with foam and none sank after repeated firing; and

(e). In various phases of ship-building.

MISCELLANEOUS APPLICATIONS. In this group are such usages as the manufacture of toys, molded objects of all shapes, and mannequins; the preparation of bandages completely permeable to X-rays, instead of the usual plaster; the manufacture of plywood for bonding and curing (low densities are particularly interesting); the manufacture of light-weight and, at the same time, highly-reinforced jigs in plants and machine shops; and in miscellaneous core applications, such as in tools or firearms, when greater strength at no expense of weight is desired. For example, the recently-introduced Armalite AR-10 Rifle has its stock made of a light-weight plastic filled with urethane foam.

SCRAP. No discussion of uses can be complete without emphasis on the important problem of scrap foam. In many of the above applications, scrap foam will be produced, and finding suitable use for this scrap will make the process advantageous and economical. Several uses have been reported in the patent literature, but have not been developed to any large and practical extent.

Acknowledgment

Deep appreciation is extended to the management of The Englander Company, Inc., through whose encouragement and cooperation this article was made possible.

—THE END

Selecting the Proper Marking Process for Plastics

(*Continued from page 41*)

Table 1. Temperatures Required for Hot-Stamping Plastics.

Plastic Materials		Temperatures °F., for "Flat Bed" Pressure Principle	Rotary "Point of Contact" Method
Class	Group		
Thermosets	Caseins	350	——
	Melamines	600	——
	Phenolics	350-600	450-500
Thermoplastics	Acrylics	350	350-400
	Cellulosics	275-350	350
	Fluorocarbons	500	——
	Nylons	325-375	325-375
	Polyethylene	325	350
	Polystyrene	325	250-375

objections to "Point of Contact" hot stamping. Furthermore, from the standpoint of plastic type, there is evidence that types which can be rolled can also be pressed, while the reverse is not true.

Printing on Plastics

The Acroprinter or equivalent unit is actually a flat-bed direct printer and can handle all of the materials listed in Table 1. We have sold inks for "job press" work on melamines, phenolics, acrylics, cellulosics (acetate and acetate-butyrate), and polystyrene. We also have supplied liquid inks for aniline-type press work on vinyls, polyethylenes, nylons, and cellulosics.

—THE END

Factors Affecting Durability of Glass-Reinforced Polyester Plastics

(*Continued from page 48*)

(1). Crinkle finish. This tends to suppress the fibers below the surface. This is generally not too uniform, unless done by means of metal dies or embossed film.

(2). Overlay mat of glass or other fiber. This can lead to trouble if the "other fiber" is not itself resistant to water or weather.

(*Continued on page 56*)

Edited by:
GEORGE E. VENTZ, *Pres.*
Atlas Machine & Tool Corp.
East Rutherford, New Jersey

Machinery Maintenance

Hydraulic Systems—Pump Failures and Sluggish Operations

PROPER operation of a pump, as well as other units of the hydraulic system, depends primarily on clean oil in a properly vented and sealed tank. The vent is necessary for breathing action due to fluctuations of the oil level in the reservoir. It should be equipped with an adequate air filter to keep foreign materials from entering. All oils should be strained before filling the reservoir and inspected periodically. Change or re-filter when necessary. During this period of shutdown, the reservoir should be cleaned thoroughly to remove all residue and sediment.

The suction line intake should be located within 2-3 inches of the reservoir bottom. The lower end of this line should be cut on an angle so as to reduce the tendency to draw in sediment from the surrounding area. The oil level must be well above this point to prevent air from entering the system, thus causing erratic operation. This would be evidenced by a sharp, crackling noise in the pump, and violent fluttering of the pressure gage needle. Excessive aeration of the oil due to improper return also will cause pump noise.

Suction line filters have been manufactured since the invention of hydraulic systems. In spite of their very complicated maintenance and troublesome aerating functions, we still find them installed in many reservoirs. Plugged or partly-blocked filters on the intake line will cause sluggish pump operation. Not only will an oil-flow obstruction bring a slow-down of the molding cycle, but also can result in costly pump repairs due to frictional wear on pressure rings, vanes, and bearings. If you still have this type of filter in your reservoir, disconnect and scrap it! After removal of these intake filters, hydraulic systems have been operated trouble-free for 15-20 years without any repair on the pumps.*

Naturally, I do not condemn all filters or strainers because, when properly positioned and maintained, they are a tremendous asset to the hydraulic system. A line filter or oil purifier of the Honan-Crane type will not only give trouble-free operation, but also will detect defective equipment or improper operating conditions. Return lines should discharge into the reservoir, below the minimum operating oil level, and as far from the pump inlet as possible. This allows the maximum time for settling of suspended foreign material and maximum time for heat dissipation. Below-the-surface return considerably reduces aeration and foaming of the oil. All pumps have a drain line which must not be restricted or plugged. This line must run from the pump to the oil reservoir, with the end of the pipe line again well below the surface of the oil. Pressure adjustments should be made only when the pump is operating against a closed circuit, and not through open center valves. Fast adjustments of pressure do not always show immediate response on gages.

In all instances, it is important to adjust the pressure to a minimum for proper operation. Excessive pressure results in wasted power and reduces the life of the pump. Small leaks in the lines often cause low pressures, and should not be taken lightly. Prompt repair eliminates this problem. Do not use white lead or other oil-soluble sealing compounds on threaded joints.

* Reference—Russel Enwright, Plant Supt., Caldwell Products, Inc., Pelham Manor, N. Y.

—THE END

PLASTICS TECHNOLOGY

EXPLORING FABRICATION TECHNIQUES

By L. J. ZUKOR, *Engineering Editor*

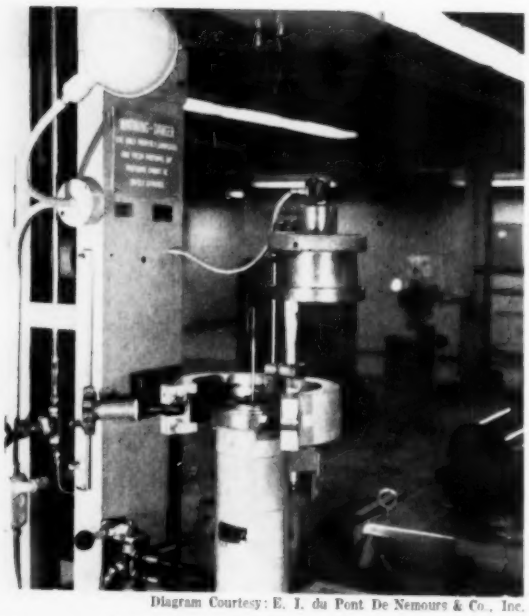


Diagram Courtesy: E. I. du Pont De Nemours & Co., Inc.

Clamp open—die lifted from cylinder.

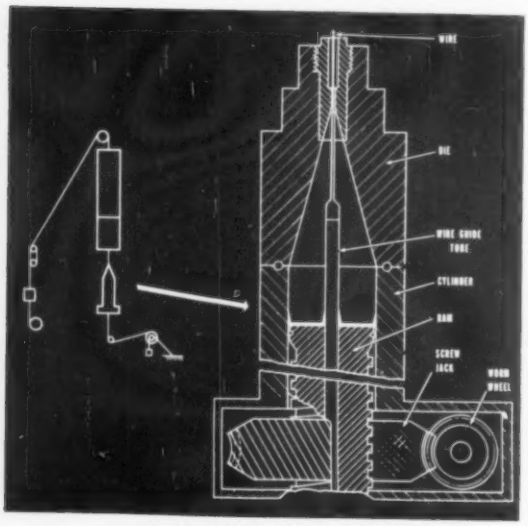


Photo Courtesy: E. I. du Pont De Nemours & Co., Inc.

Ram mechanism.

Fluorocarbon Resins . . .

. . . as wire and cable insulating materials are well suited to the rigorous, present day applications. Jet aircraft, atomic piles and rocket craft have many operational characteristics in common with each other; i.e., extreme operating temperatures, presence of corrosive chemicals and gases, and, last but not least, need for high frequency equipment.

The trend in the electronics industry for the past decade has been towards the design of smaller and lighter equipment; in a word, "miniaturization." Generally the fluorocarbon resins may be employed in smaller radial thicknesses than any other plastic or rubber for the same or higher insulation resistance. The importance of this plastic lies in the fact that it is universally more suitable for a wider range of applications than earlier wire and cable insulations. Another desirable characteristic of fluorocarbons is the fact that their extremely high insulation resistance does not deteriorate with time, temperature, humidity, or other adverse environmental conditions. At the present writing, no other plastic exists which provides a lower dielectric constant (2.1) or dissipation factor (.0003) than fluorocarbons. The high insulation resistance of this plastic, even at 100% relative humidity, minimizes current leakage between conductors, thus greatly reducing or eliminating "noise" or "cross-talk." All in all, these favorable physical characteristics offer the electrical and electronics manufacturer a greater assurance against circuit failure due to wire insulation breakdown.

The fluorocarbon resins used in volume are DuPont's Teflon 6-TFE and Minnesota Mining & Mfg. Co.'s Kel-F 500. The former is a completely fluorin-

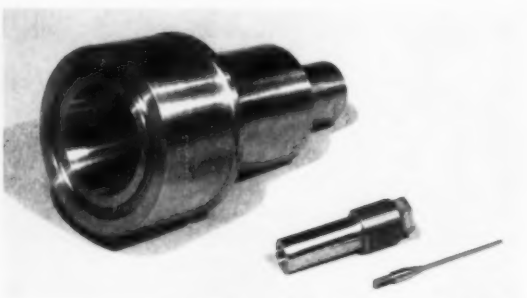
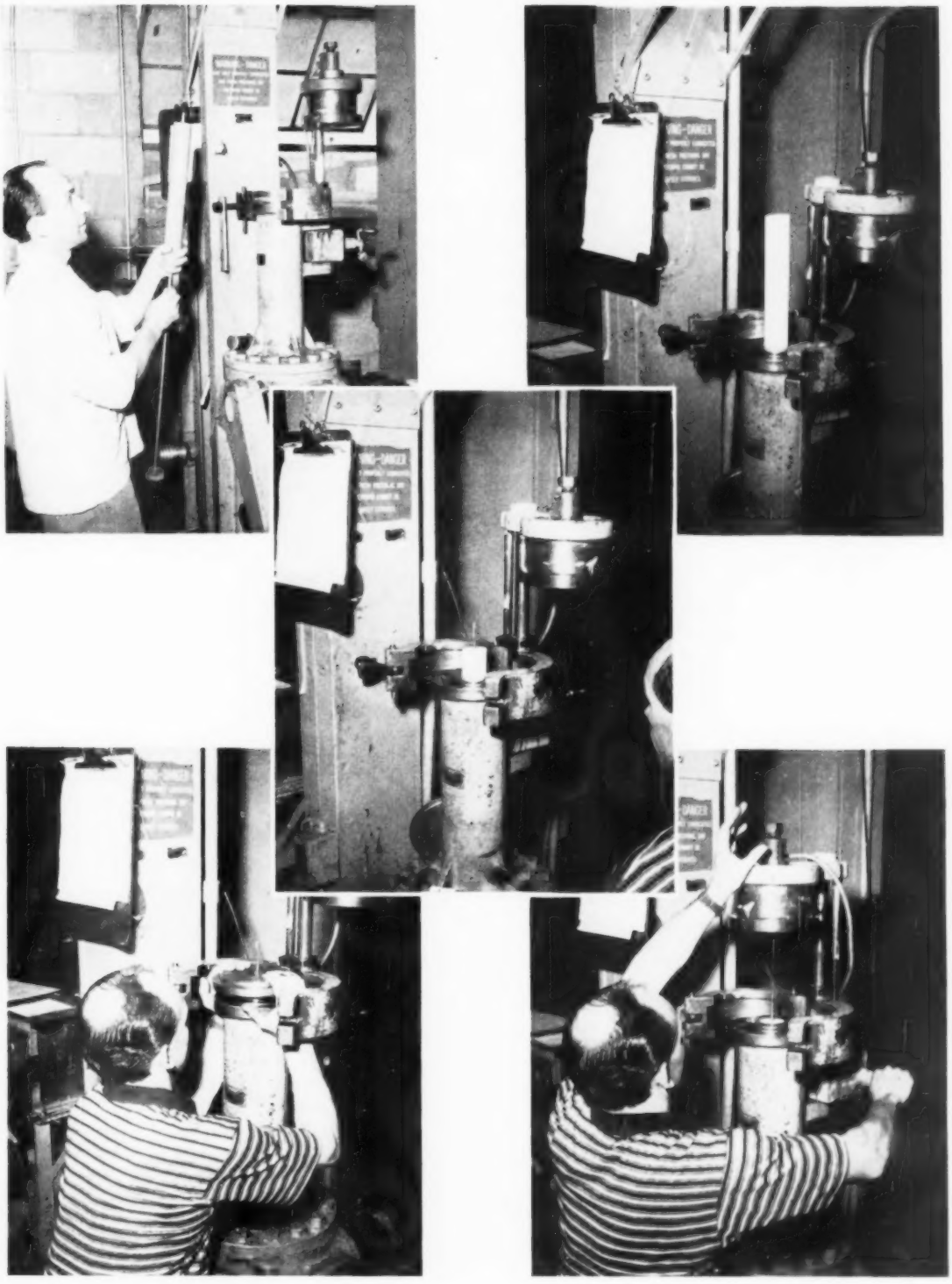


Photo Courtesy: E. I. du Pont De Nemours & Co., Inc.

Conical die, die insert, wire guide tip.



Photos Courtesy: Tensolite Insulated Wire Co., Inc.

Upper left: Removing preform from core rod. Upper right: Loading preform. Center: Preform moved down over wire guide tube and wire guide tip. Lower left: Preform bottomed in cylinder. Lower right: Wire pulled through die insert.

Photo Courtesy: Tensolite Insulated Wire Co., Inc.

Wire connected to lead wire ready to be pulled through ovens.

ated polymer, with a very high viscosity in the gel state which precludes its extrusion by conventional means. The latter contains chlorine as well as fluorine atoms, and is extrudable by conventional means through a crosshead die. A recently introduced member to this family is designated 100X-FEP, similar to the TFE resin, also a DuPont product. This resin is presently available only in limited supply. Like Kel-F, 100X-FEP resin is also extrudable by conventional means. However, this material cannot compete with TFE resin until such time as it is more readily available, and until the price structure is reduced to a more equitable figure. By and large, the material most frequently specified in wire applications is still Teflon 6-TFE. 100X-FEP resin (according to the manufacturer) is not intended to compete with TFE resin, but rather compliment it in other applications, particularly in injection molding. Here, unlike the TFE resin, it acts like a true thermoplastic. Because 100X-FEP was designed for thermoplastic use, its heat deformation point is lower than that of TFE resin.

Wire manufacturers presently extruding vinyl and polyethylene, and who contemplate the use of 100X-FEP or Kel-F 500 resins, should be mindful of some major modifications that must be made in their existing equipment. The higher heats required for the fluorocarbon resins require additional heater bands, to obtain an increase in watt density. Also, in prolonged operations, a high nickel-alloy cylinder liner is advisable. All other parts in contact with the heated resin, such as the screw and die lands, also should be protected by nickel-alloy plating against corrosion or pitting by the resin.

Conventional extrusion of thermoplastic materials will be covered in future articles and its discussion at this time would only distract from the specific novelty of the method required for fabricating the TFE resin. The extrusion process here resembles the cold extrusion and swaging operations used in processing soft metals; however, unlike metal extrusion, extremely large area reductions are possible. In processing TFE resin, special equipment and handling techniques are used. The extruder is manufactured by Jennings Engineering Inc., and was developed by them in conjunction with E. I. du Pont de Nemours & Co., Inc.

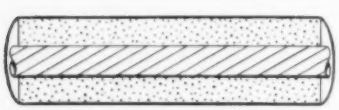
Teflon 6-TFE resin is first mixed with a lubricant, such as VM&P naphtha and a pigment. This mixture is preformed to the shape of the extruder cylinder, and the preforms are then transferred to the extruder which is set up with wire that has been fed through a wire guide tube and guide tube tip. The wire is embedded in the polymer at a point near the top of the conical die where wire and extrudate emerge at the same velocity.

From the extruder, wire and extrudate pass through two ovens; the first is heated to 350-575° F., to volatilize the lubricant. Then it passes through the second oven, which is at 650-750° F., where the coating is sintered or fused. The capstan, wind-up, pay-off, and spark testing equipment are standard for wire-coating operations.

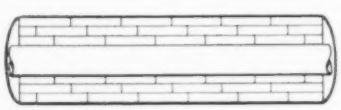
Few companies are making fluorocarbon-insulated wire, due mainly to the high investment in machinery and the resin cost. Of this small group, one company, Tensolite Insulated Wire Co., Inc., Tarrytown, N. Y., are specialists in the preparation of all types of fluorocarbon insulations, and devotes almost all of its production to this one type. Because of their know-how and excellence in processing, they are allowed to operate a bonded warehouse. This, in effect, permits them to make immediate shipment of approved wire to any of the government services, as well as to their other customers.

Tensolite also insulates wire by all other known processes; namely, spiral wrapping, parallel wrapping, and dip-coating. The parallel-wrap method is their proprietary process for obtaining improved dielectric strength and greater flexibility. This method also allows manufacture of longer than average lengths of flaw-free insulation. Another advantage that the parallel wrap method offers, is the protection of the color code pigments by a top protective layer of colorless Teflon integrally bonded to the colored layers.

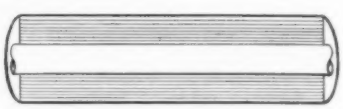
—THE END



Extruded



Spiral Wrap
(1/3 Lap-no overlap)



Parallel Wrap
(Approximately 8 layers)

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Clarifying U. L's. Position on Plastics in Air-Conditioners

(*Cont'd. from page 49*)

the Industry Advisory Conferences of March 4, March 20, April 3, and April 30, and proposals sent to all interested parties for review and comment.

Questions now have been asked on two specific uses of thermoplastics to indicate the thinking of the Laboratories' staff. One was whether slow-burning knobs would be acceptable on air-conditioning equipment where no other combustible materials were used in the interiors of the equipment. The answer was definitely that such knobs would be acceptable.

The other question was whether grills or decorative fronts of slow-burning material would be accepted in air-conditioning equipment where no other combustible materials were used on the interiors and away from the electrical system, so that any failures in that system would be unlikely to ignite the grills. The answer was that such grills would be acceptable. These slow-burning materials may be used under other conditions depending on the design of the equipment.

It is hoped that this explanation will help toward understanding of the proposals that have been widely misinterpreted.

—THE END

Factors Affecting Durability of Glass-Reinforced Polyester Plastics

(*Cont'd. from page 50*)

Conclusions

As is the case in any paper that attempts to analyze some of the basic factors contributing to performance of materials, there are obvious omissions. Some of the factors can be mentioned only in passing due to space limitations. However, certain composition variables with proven importance to durability have been discussed, and proposals have been made to explain their performance from a theoretical standpoint. These explanations have been confirmed by actual tests and practical test installations.

Finally, an attempt has been made to relate physical/chemical properties of polyesters to their weathering performance in glass-reinforced plastics. It is the hope of the authors that such treatment, although somewhat sketchy, will stimulate thinking and result in still further improvement of the outdoor performances of reinforced plastics.

Acknowledgment

The assistance of J. J. Gouza and his associates S. Chmielewski and C. G. Ramer, in conducting physical tests and photographic work is gratefully acknowledged.

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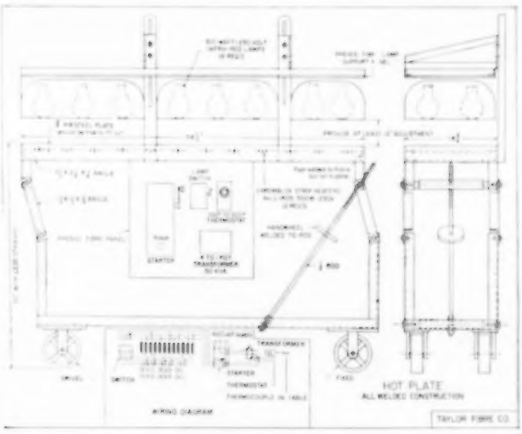
—THE END

Hoehn Replaces Blitz on PT Editorial Advisory Board

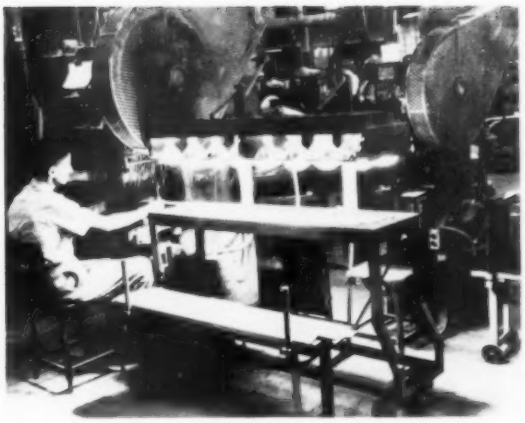
Owing to the pressure of his work with his company, Saul Blitz, President of Tico Plastics, New York, N. Y., has been forced to resign from our Editorial Advisory Board. He had served as our authority on Injection Molding since the publication's inception. Effective June 1, he is replaced in our ranks by Robert H. Hoehn, Chief Engineer for Mack Molding Co., Inc., Wayne, N. J.

Bob Hoehn was born in New York City in 1921. He attended the Newark College of Engineering, but left in 1942 to join the Armed Services. Since the War, he has been with Mack Molding, and was named Chief Engineer in 1947. He has been active in the Newark Section of SPE where, after holding all other elective offices, he served as president of the Section in 1957. His other memberships include the American Ordnance Assn., the United States Power Squadron, the Elks, and the Manasquan River Yacht Club. As can be imagined, his major interest as a hobby is in power boating. Mr. & Mrs. Hoehn have two children, and make their home in Verona, N. J.

—THE END



Outline of Taylor Fibre heating table for the "do-it-yourselfer."



Laminates are preheated above and below, then hot-punched.

Heating Table Speeds

Hot-Punching Process

AN infrared-assisted heating table for preheating plastic laminates prior to hot punching has been developed by Taylor Fibre Co., Norristown, Pa. Designed to heat simultaneously from both above and below, the table is said to eliminate 80% of the problems encountered by the fabricator in the hot-punching process.

Strip to be punched is heated from below by a conventional hot plate on which it rests. At the same time, infrared lights can be focused on the strip from above. By producing just the right heating conditions, cracks (strip too cool) and off-specification holes (strip too hot) are obviated. Manufacturer's recommendations for proper temperatures are based on grade and thickness of the material, plus tightness of the specifications, and thus serve only as the starting point. It is still necessary for the fabricator to determine the optimum conditions, and uniform heating is of great assistance.

With thin stock it may be desirable to use either one or both banks of lights alone, heating both the work and the plate. One bank of lights adds about 100° F.; both banks, 200° F. The table is designed mechanically for maximum flexibility and convenience. It can be wheeled between presses, and has a hand wheel for height adjustment. This latter feature permits matching of table height to different presses and die sets. Taylor uses the infrared lights on 15-20% of all phenolic work.

—THE END

Fig. 1. Scale model of a reinforced plastic pavilion.

Reinforced Plastic Pavilions

FOUR reinforced plastic pavilions of the type shown in the accompanying photograph are being assembled in Moscow's Sokolniki Park as part of the American National Exhibition. The first official U. S. fair ever to be held in Russia, the exhibition opens July 25 for a six-week period. It is intended to project a realistic image of American life through exhibits, displays, films, publications, fine arts, and performing arts.

To meet a July opening date, time did not permit obtaining a special supplemental appropriation from Congress. Funds already available were earmarked for the aluminum gold-anodized geodesic dome and the fan-shaped glass and aluminum exhibition hall. However, the plastics industry once again came through in fine style. Forty-one firms actively engaged in plastics work contributed a total of $151,680 to erect the plastic structures which will house the architectural and photographic exhibits as well as a live fashion show. Their names are listed at the end of this article.

In addition, the fabricator, Lunn Laminates, Inc., took on the job at cost.

Designed by George Nelson & Co. with Albert G. H. Dietz as consulting engineer, the pavilions are free-form structures without outer walls. Each pavilion consists of 20 inverted, hexagon-shaped umbrellas supported by a hollow 16-foot column. The umbrella is formed by interlocking six molded units. Wind velocity testing at Mitchell Air Force Base attested to the stability of the structure. Approximate weight of each "parasol" (there are 90 in all) is 600 pounds. The hollow column allows drainage of rain water and will be anchored to concrete footings.

Polyester resins chosen for the job were of the fire-retardant type, and the catalyst was selected for its ability to effect cure at room temperature. Color of the units is the natural, off-white color of polyester resins and glass mat. Lunn shipped the finished structures in sections for assembly on-the-job.

To date, no similar type structure has been attempted using reinforced plastics exclusively. The design suggests any number of outdoor shelters such as kiosks, bus stop sheds, canopy substitutes, and seasonal food and souvenir stands. Another thought is pure decoration—the remaining "parasols" are scattered throughout Sokolniki like trees (this accounts for the other ten about which some of our more mathematical readers may have worried).

"More and more designers are turning towards reinforced plastics," according to Mr. Nelson, "because experimentation with unusual forms is not prohibitive moneywise." Plaster, wood, or plastic dies plus the adaptable vacuum bag equipment may not represent automation, but neither do they represent big investments. Volume production need not be reached to amortize costs.

The following companies helped put over this program:

Owens-Corning Fiberglas Corp., Reichhold Chemicals, Inc., American Cyanamid Co., Union Carbide Plastics Co., Allied Chemical Corp., Hercules Powder Co., Foster Grant Co., Shell Chemical Corp., E. I. du Pont de Nemours & Co., B. F. Goodrich Co., Rohm & Haas Co., Monsanto Chemical Co., Celanese Corp. of America, Firestone Tire & Rubber Co., Food Machinery & Chemical Corp., United States Rubber Co., Goodyear Tire & Rubber Co., General Tire & Rubber Co., Ferro Corp., Filon Plastics Corp., Cosden Petroleum Corp., Bostrom Corp., Molded Fiber Glass Body Co., Plastex Co., Claremont Pigment Dispersion Corp., Argus Chemical Corp., Plastics Products Corp., Chicago Gasket Co., Pennsylvania Fluorocarbon Co., General Products Corp., Southern Plastics Engineering Corp., Danbury Plastics, St. Regis Paper Co., W. R. Grace & Co., Hooker Chemical Corp., Brunswick-Balke-Collender Co., Dow Chemical Co., Spencer Chemical Co., Revell, Inc., Specialty Resins Co., and Frank W. Egan & Co. —THE END

Fig. 3. Section of top is removed from mold.

Fig. 2. Crane lowers hexagonal unit onto column.

Fig. 4. Hexagonal roof section is raised by crane.

NEWS of the Industry

corporate name changes

Carbetex Chemical Co. has changed its name to **General Resin Corp.** Ownership and corporate structure will remain the same. The firm is located in Tewkesbury, Mass.

National Starch & Chemical Corp. is the new name for **National Starch Products, Inc.** The move is said to reflect the increased importance of chemical products and processes in the firm's business. National is currently one of the largest producers of vinyl acetate polymers and copolymers in emulsion form.

Hostachem Corp. is the new name for **Progressive Color & Chemical Co., Inc.,** of New York City. The company decided to identify itself more closely with the origin of its products—namely, those of Farbwerke Hoechst, Frankfurt, West Germany.

new agents and distributors

F. J. Stokes Corp. has taken over the production and marketing of **Zimmerman Machinery Co.'s** manifold-type blow molding equipment. This equipment is to be offered free of any royalty requirements, and should help build up the blow molding field.

Sanitized Sales Co. of America, Inc. has licensed 16 firms to use its additives in plastic film, housewares, home furnishings, lingerie, hosiery, and textiles. This brings the total number of firms using Sanitized's bacteriostat to about 725.

Reichhold Chemicals, Inc., has signed a license agreement with **Probst & Cia., Ltda,** Medellin, Colombia, whereby the latter will produce resins using techniques developed by RCI. Most of the products will be in the surface coatings and adhesive fields.

Thoreson-McCosh, Inc., has appointed **Plastic Molders Engineering Co.,** as its representative in the Chicago area.

Isocyanate Products, Inc., Wilmington, Del., has named **Midwest Technical Service** of Downers Grove, Ill., as its midwestern sales and service representative. The latter firm is headed by T. J. LaBounty.

Rumianca Chemical Corp., New York City, will represent **Rumianca S. p. A.,** in the United States and Canada. The latter firm is one of Italy's largest chemical companies.

Belding Corticelli Industries has completed an agreement with **Organico S. A.,** of France, to market Type 11 nylon resins in the United States. Derived from castor bean, these resins have received broad acceptance in Europe for several years. Plans for domestic production will follow at an early date.

changes in ownership, new companies

Koehring Co. has acquired the complete business of **Cast-Master, Inc.,** Bedford, O., manufacturer of die casting machines. The firm will operate as a division of Koehring's Hydraulic Press Mfg. division, Mount Gilead, O. Purchase price, involving a stock transfer, was said to exceed $1½-million. Cast-Master owners, Clarence E. Taylor and Howard P. Miller, will join the Koehring organization.

Hawaiian Extruders, Inc., is the name of a new firm established jointly by **Dow Chemical Co.,** and **Pacific Chemical & Fertilizer Co.** The firm will be located in Honolulu, and its president will be R. Q. Smith, who is also president of PC&F. Operations will call for about 15 employes.

Valco, Inc., has been set up in St. Petersburg, Fla., as a manufacturer of decorative and industrial fiberglass-reinforced polyester paneling. Offices and research center were opened recently at 7500 Fourth St., North, and full-scale evaluation programs are underway. Company president is Henry Valus and vp-general manager is Anver S. Suleiman, formerly of Monsanto.

J. Harry DuBois, well known plastics consultant, has purpurchased **Tech Art Plastics Co.,** Morristown, N. J. Tech Art is the former **Boonton Rubber Co.,** the first plastics molding company, and is currently specializing in the automatic molding of both thermosetting and thermoplastic materials.

Sales are handled by **Insulating Fabrictaors Co.,** East Rutherford, N. J., and **Insulating Fabricators of New England,** Watertown, Mass. Mr. DuBois will serve as chairman of the board. Harold J. Cook will continue as president, and John Lombardi has been named vice president in charge of manufacturing.

Studebaker-Packard Corp. has purchased **Gering Products, Inc.,** Kenilworth, N. J., and plans to operate it as a separate division. Financial details were not announced. Gering will continue to operate as a producer of plastic materials and products under the management of Larry and Herman Gering, the original owners.

News of Industry *(Cont'd.)*

Moldings & Extrusions, Inc. (Moldex), is a new firm specializing in precision molding and extrusion of plastics. Main offices, plant and extrusion department are located in Wauregan, Conn.; the general molding division is located in Great Neck, L. I., N. Y. (the former General Molding Co.). Moldex president is John E. Holt; executive vice president, Carl Pite; and engineering and manufacturing vice presidents are Harold and Randolph Schlener, respectively.

Chicago Molded Products Corp. has acquired **Capac Plastics, Inc.,** Minneapolis, Minn., and will modify its plant to incorporate advance techniques for producing Campco sheet and film. The Capac plant will be operated under the direction of Edward F. Bachner, Jr., vice president.

Coz Chemical Corp. has been formed in Northbridge, Mass., by Alfred and Henry Coz. A new, fully automated plant is in operation producing thermoplastic materials. Covering 31,000 square feet on one floor, it includes a laboratory specifically designed to duplicate plant production facilities in lab quantities. The founders of the company have been actively engaged in the plastics industry for over 14 years.

Cutler Laboratories, Berkeley, Calif., has acquired all assets of **Olympic Plastics Co., Inc.,** a large manufacturer of plastic containers. Plans are underway to increase plant capacity, and a new building will be erected at the present site. Staff and operating personnel remain unchanged.

Sterling Extruder Corp. is the name of a recently-established extruder manufacturer located in Linden, N. J. The firm is manufacturing units from 1½ through 6 inches in bore and in 15:1, 21:1, 24:1, and 30:1 L/D ratios. In addition the firm manufactures auxiliary equipment for extrusion purposes. President of the company is L. D. Yokana.

Allied Chemical Corp. has completed negotiations with **B. F. Goodrich Co.** for acquisition of **Harmon Colors,** a manufacturer of specialty organic pigments located in Haledon, N. J. Harmon had been a part of Goodrich's chemical division. The move marks Allied's entry into the pigments field and should combine well with dyes currently being offered by **National Aniline.**

Achsen-Grannan, Inc., has been established in New York City to act as sales representative for the plastics division of General Tire & Rubber Co. The new firm consolidates territories previously covered by sales reps in New York, New Jersey, Pennsylvania, and other Middle Atlantic States. Officers are David Achsen and Joseph Grannan, former sales representatives for Bolta Products.

Dayton Industrial Products Co. has been formed as a division of **Dayton Rubber Co.,** with headquarters in the Melrose Park area west of Chicago. The new division will handle a growing line of industrial and automotive products.

company moves and expansions

Chemore Corp., general representatives in the United States and Canada for Montecatini, has moved to larger offices at 2 Broadway, New York City.

Industrial Hydraulic Machine & Design Co., Rahway, N. J., has announced an expansion of facilities and management. The firm specializes in the service, repair, rebuilding, and building of hydraulic presses.

Continental Plastics has announced plans for doubling the size of its new (one year) plant to meet increased needs for custom molded parts. Located in Oklahoma City, the firm will install the latest in automatic injection molding equipment.

Dobeckum Co. has moved its Boston branch office to new and large quarters at 520 Boylston St. This move reportedly consolidates its activities with those of the parent organization, **Dow Chemical Co.,** and moves all sales and counseling services under one roof.

Union Carbide Chemicals Co. has doubled its capacity for producing polyether polyols at its South Charleston, W. Va., plant. Designed to meet increased demands by producers of polyether urethane foams, the new facilities have incorporated process improvements which result in a purer product. The firm has available eight polyethers under the trade-name Niax.

Modiglass Fibers, Inc., has added 10,000 square feet of space to its present manufacturing facilities at Bremen, O., expressedly to meet demands for continuous-fiber reinforcing mat. Occupancy is scheduled for mid-July.

Atlas Powder Co. has announced plans for moving its Thermaflow operations from Tunkhannock, Pa., to its Atlas Point plant near Wilmington, Del. This move is part of a $¼-million expansion program, and affords easier access to polyester resin sources, plus research & development facilities and technical personnel. Atlas acquired Thermaflow in October, 1956.

Durable Formed Products, Inc., has set up a plastics tool making department which will specialize in precision construction of plastic thermo-forming tools from epoxy resins. The department will supply requirements for the firm and its associate, **Techni-Plastics, Inc.** The companies now can supply customers from design to finished product.

DOW Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

THREE DIMENSIONAL ANALYSIS IS VITAL TOOL IN PLASTICS MATERIAL SELECTION

In selecting a plastics material for optimum use in a given design application, the best results can be obtained only by comparative analysis of *all* available related data.

QUALITY CONTROL DATA are often taken at a single point of measurement (at times this may be the only available datum for a given property) and may appear to be valid basis for selection. This can be misleading. In the case of two hypothetical plastic materials under consideration, Figure 1 shows how both exhibit the same degree of deflection under identical loads at a given temperature. Thus both would appear to be equally suitable for the job at hand based on this cursory analysis.

SCREENING DATA, developed through further investigation, now show that plastics "A" and "B" have totally dissimilar curves and properties. Figure 2 illustrates the curves generated when temperatures are plotted against increasing stress at a uniform measure of deflection. The misleading single point in Fig. 1 now appears only as the crossing point of the two dimensional curves. The difference in deflection temperature between the two samples is unmistakable.

DESIGN AND ENGINEERING DATA require further analysis. A three dimensional curve of deflection temperature, stress and allowable deflection is now plotted for each of the plastics. Figure 3 illustrates such a diagram for plastic material "A". Only in this way can we get a full picture of the material's potential value under possible changing conditions of use.

A great deal of experimental work is required to accumulate data sufficient to develop such three dimensional curves, but their ultimate application in design work makes them invaluable. Because of their inherent value to design engineers, Dow Plastics Technical Service Engineers are conducting extensive research in the gathering of multi-dimensional data on a number of Dow molding material formulations. This work is part of a continuing series of Plastiatrics studies aimed at assisting designers and engineers in the most effective selection of plastics materials.

For more information on this important work, and on data presently available, write Plastics Sales Dept. 2103DT6, THE DOW CHEMICAL COMPANY, Midland, Michigan.

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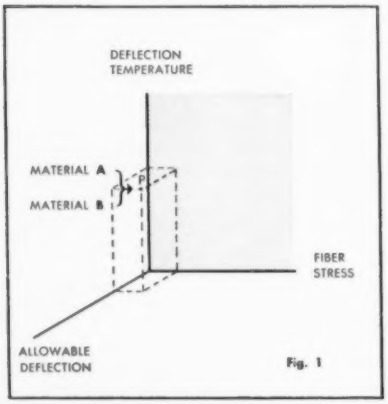

Fig. 1

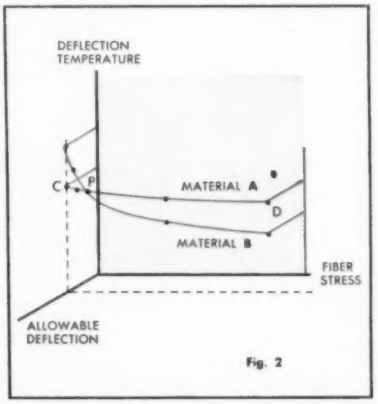

Fig. 2

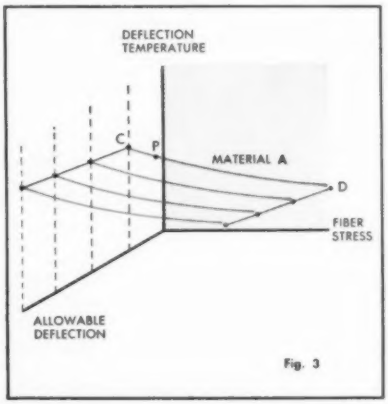

Fig. 3

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

News of Industry *(Cont'd.)*

Riverside Plastics Corp. plans to add 14,000 square feet to existing plant in Hicksville, N. Y. Scheduled for completion by July 1, the move represents an investment of $100,000. Areas will be allocated for both research and production facilities.

Owens-Corning Fiberglas Corp. plans to relocate its basic and applied research and its product testing laboratories from Newark, O., to a 150-acre site near Granville, O., where its pioneering laboratory is located. Scheduled for occupancy late this year, the new facilities will consist of four buildings with a total of 100,000 square feet of floor space.

Koppers Co.'s plastics division expects to lease about 133,000 square feet of space in the former Hudson Motor Car plant in Detroit for the manufacture of Dylite expandable styrene sandwich panels. Equipment is already on order, and production is anticipated by fall. At peak production, 140 persons will be employed.

Hexcel Products, Inc., has completed facilities for the mass production of structural paper honeycomb core materials. The Berkeley, Calif., firm is also expanding its capacity to produce impregnated paper honeycomb.

Dow Chemical Co. has doubled its polyethylene capacity for the second time in a year. Both plants are located at Freeport, Tex., where Dow first entered polyethylene production in 1955, and both employ the method licensed by **Imperial Chemical Industries.** As the second unit went on stream, Dow announced the start of construction on another polyethylene plant at its Louisiana division near Plaquemine.

Goodyear Tire & Rubber Co. has embarked on a multi-million dollar expansion program which will more than double its capacity for producing vinyl flooring and counter tops. Facilities and labor force will be expanded, and new equipment will be installed at the subsidiary Goodyear Aircraft Corp.'s Plant B —site of the firm's present manufacturing facilities for vinyl film and flooring. April 1 of next year is the target date for completion of the project.

A. E. Staley Mfg. Co., Decatur, Ill., has announced its entry into the synthetic polymer field. A processor of corn and soybeans, the firm launched its research and diversification program three years ago with the construction of a pilot plant for the semi-works production of acrylic emulsions. Staley also announced plans for the acquisition of **UBS Chemical Corp.,** of Cambridge, Mass. (subject to stockholder approval), which will give them a chemical plant and laboratories, a polymer plant at Lemont, Ill., a polymer plant and lab currently under construction at Marlboro, a tech lab at Greenville, S. C., and other UBS facilities.

Borden Chemical Co. has transferred its government services department from New York City to its coatings and adhesives plant in Middlesex, N. J.

Dia-Chrome Co. has moved to new quarters at 612 W. Elk Ave., Glendale, Calif. This is the third expansion for the firm in five years, and much added equipment should enable the firm to handle the many demands by the plastics industry for coated steel tools. A new experimental and production division is being formed to test, machine, and work new, hard abrasive materials. Consulting services will be available.

Carwin Co., North Haven, Conn., has completed its second unit for the manufacture of mono-, di-, and poly-isocyanates. As a result of this added capacity, Carwin is now offering ethyl isocyanate and phenyl isocyanate in commercial quantities, and plans to make available other aliphatic isocyanates.

Plax Corp. has purchased the exclusive rights to U. S. Patent No. 2,811,468 and related worldwide patents for the fluorination of plastics from **Shulton, Inc.** Plax has been experimenting with fluorination as a means for reducing the permeability of polyethylene and other thermoplastics, and expects to use it for containers, molded parts, and film.

Diamond Alkali Co. has begun an estimated $½-million expansion program which will add 5,000 square feet of lab space and experimental processing equipment to its plastics technical service and applications laboratory. The firm's research center is located in Painesville, O.

National Vulcanized Fibre Co. now offers extrusions and fabricated parts of DuPont Delrin resin. Strip comes in widths to seven inches and thicknesses of 0.02-0.093 inch; rod diameters range from ½-2 inches; tubing and special shapes are made to order.

Emery Industries, Inc., has moved its Chicago offices to 6835 West Higgins Ave. The firm's present warehousing operation remains unchanged.

Sterling Alderfer Co., Akron, O., has just shipped the nucleus of a polyurethane foam plant to **Molan-Werk Erich Dittrich** in Bremen, West Germany. This includes the actual equipment plus blueprints and construction details for the units to be manufactured on the plant site. The German firm has taken out an exclusive license for all Western Germany and expects to be in production within three months.

Northern Plastics Corp., LaCrosse, Wis., has installed $150,000 of additional equipment, including an automatic materials handling system which delivers resins from underground storage tanks direct to coating machines. Production capabilities are increased by an estimated 35%.

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News of Industry *(Cont'd.)*

new plants and laboratories

E. I. du Pont de Nemours & Co., Inc., plans to build a second Mylar plant near Florence, S. C. Construction has just begun, and the $20-million project should be completed early in 1961. The film dpeartment will operate the plant which will employ about 500 workers.

Continental-Diamond Fibre Corp. has scheduled new research facilities at Newark, Del. Plans call for completion of the project by August of this year. Finished, it should greatly expand the firm's product line through research and development activities.

Bell Telephone Laboratories has announced plans for building a $20-million laboratory in Holmdel, N. J., to meet the expanding needs for research and development to advance communications. A 430-acre site has been set aside for the project, and Eero Saarinen has been named as the architect.

austrian polypropylene

Danubia Petrochemie, A.G., has announced its plans for producing Daplen, a polypropylene material. The firm, which is owned by **Oesterreichische Stickstoffwerke, Montecatini,** and private Austrian capital, showed sample material at the Vienna Fall Fair. Actual material shown was made by Montecatini, who also made sufficient quantities available to molders for experimental processing.

argentine styrene plant

Industrias Plasticas Argentinas Koppers, S. A., is planning to construct a styrene monomer plant near Buenos Aires, Argentina. The unit will cost approximately $7.5-million, and will have a capacity of about 15,000 metric tons annually. Earlier, the firm announced plans to build a $16-million ethylene and polyethylene plant following the grant of $8-million credit by Export-Import Bank.

english maleic anhydride unit

Monsanto Chemicals, Ltd., plans to erect the largest maleic anhydride plant outside the United States in Newport, Monmouthshire, England. Scheduled for completion by the latter half of 1960, the plant will have a capacity of 15-million pounds annually. **Scientific Design Co., Inc.,** will undertake the project using its own process.

styrene in australia

CSR-Dow Pty., Ltd., has been formed in Australia for the production of styrene. Owned jointly by **Dow Chemical Co.** and **C. S. R. Chemicals Pty., Ltd.,** a leading Australian chemical manufacturer, the firm has a plant on schedule which should be completed by mid-1961. Melbourne is the site.

swiss branch for du pont

Du Pont de Nemours International, S. A., has been set up by the parent Du Pont organization as a Swiss sales company with headquarters in Geneva. The new firm will help plan and implement European sales programs for products to be manufactured by Du Pont subsidiaries in that continent. Initially, it will be concerned with the sale of textile fibers and elastomers, however, other products will be added later.

canadian cyanamid expansions

Cyanamid of Canada, Ltd., plans to spend $1½-million in converting its plant facilities at St. Jean, Que., for the production of Formica laminated plastics. Floor space will be increased by more than 50%, and a Canada-wide sales organization has been established. Completion is expected within a year.

(Continued on page 84)

News of the Societies

C. Russell Mahaney

Russell C. Weigel

SPI Elects Officers

Meeting May 15th in New York City, The Society of the Plastics Industry, Inc., elected Russell C. Weigel president and director for the next two years. Mr. Weigel of Du Pont's Polychemicals Dep't., took office June 1st, succeeding C. Russell Mahaney, St. Regis Paper Co., who has been elected chairman of the board.

Kurz-Kasch, Inc.'s Robert L. Davidson moves into the vice presidency, and E. J. Caughlin, American Insulator Corp., takes over as secretary-treasurer.

Division chairmen elected to SPI's board of directors include: Cellular Plastics, Samuel Steingiser, Mobay Chemical Co.; Engineering & Technical, Kenneth Perkins, Diehl Mfg. Co.; Film & Sheeting, James W. McLaughlin, Union Carbide Plastics Co.; Flurocarbons, Edgar S. Peierls, Resistoflex Corp.; Housewares, Douglas L. Jocelyn, Plastray Corp.; Machinery, A. J. de Matteo, Watson-Stillman Press Div., Farrel-Birmingham Co.; Melamine Dinnerware, W. L. Cone, Plastics Mfg. Co.; Mold Makers, W. H. Monteith, Akromold, Inc.; Reinforced, A. W. Levenhagen, Molded Fiber Glass Tray Co.; Thermoplastics Pipe, George C. Anderson, National Tube Div., U.S. Steel Corp.; and Weatherstrip, Milton J. Lax, Kreidel Plastics, Inc.

New board members among the section chairmen are: Canadian, M. Wilkinson, Canadian Industries Ltd.; Midwest, Edward Singer, Victory Mfg. Corp.; New England, Otto Morningstar, The Morningstar Corp.; West Coast, John Delmonte, Furane Plastics, Inc.

In addition, the following directors-at-large were elected: Chester Anderson, Rexall Drug Co.; Los Angeles, Calif.; Ralph T. Brotz, Plastics Engineering Co.; Louis J. Francisco, American Cyanamid Co.; Sydney Lewis, Advance Molding Corp.; W. F. Oelman, Standard Molding Corp. J. D. Proctor, Celluplastic Corp.; Owen E. Skelton, Modern Plastics Corp.; Jay G. Somers, Consoweld Corp.; George Wash, Phillips Chemical Co.; C. C. Whitacre, Midwest Plastics Products Co.; and Roger B. White, The Plastics Corp.

SPE 16th ANTEC

The 16th Annual Technical Conference, sponsored by the Society of Plastics Engineers, Inc., will be held January 12-15, 1960, at the Conrad Hilton Hotel, Chicago, Ill. Conference Chairman Franklin L. Fine, Rohm & Haas Co., reports that many of the symposia will be based on the Professional Activities Groups of the Society. Included among these are: Plastics in Building, Injection Molding, Polymer Structure and Properties, Reinforced Plastics, Standards for Reporting Properties, Fabricating, Finishing, Plastics in Electrical Insulation, Casting and Plastics Tooling, Forming, Extrusion, Thermosetting Molding, Metals for Plastics Molds, Vinyl Plastics.

SPI Tooling Division

Society of the Plastics Industry's Tooling Division, meeting April 30th at Stouffer's Northland in Detroit, heard Frank Bogart discuss the effects of cure cycles on epoxy tooling resins. Among the topics covered were the phenomena of shrinkage, stability, exotherm heat, and physical properties of resins cured with different hardeners and at different temperatures. Laminating, casting, and heat cure resins were discussed, as well as procedures used in casting very large plastic tools weighing several tons.

SPE Cleveland Section

Blending of high and low density polyethylene to obtain a medium density material was discussed recently by Fred C. Sutro in a talk "What's New in Medium Density Polyethylene," presented before the Society of Plastics Engineers' Cleveland section. Mr. Sutro, who is polyethylene product manager for Spencer Chemical Co., and national president of the SPE, said that the use of blends has taken its place as a third method of producing polyethylene in the medium density range. The other two methods are production in a conventional high-pressure plant, and the still-experimental methods which use the low pressure process.

Resins of the same density in this intermediate range will have nearly comparable properties, regardless of how they are produced. Though some differences in physical properties of the end-product exist, both materials exhibit essentially the same behavior during extrusion and injection molding.

As to markets, estimates are that medium density resins will account for 20-25% of the billion pound total which has been predicted for polyethylene in 1960.

Polypropylene's Future

A bright future for polypropylene was predicted at the 40th National Meeting of the American Institute of Chemical Engineers, held recently at Kansas City, Mo. In a technical paper prepared by W. R. Gutman, H. W. Fleming, and J. S. Cromeans, of Catalysts and Chemicals, Inc., Louisville, Ky., it was stated that "There are sound reasons to anticipate that polypropylene production will increase rapidly within three years and that it will join polyethylene among the foremost hydrocarbon polymers."

As in the case of ethylene for polyethylene, the propylene for polypropylene will need to be of exceptional high purity. A recent improvement in the selective hydrogenation process, wherein the acetylene is streamed over a nickel-cobalt-chromium catalyst, has proved not only technically superior but more economical than other commercially available systems.

Although successful in ethylene production, some kinks remain to be ironed out in selective hydrogenation of methyl acetylene, propadiene, and carbonyl sulfide. At Catalysts and Chemicals, Inc.'s laboratories, carbonyl sulfide has been successfully converted catalytically to less than 10 ppm. without loss of propylene. Methyl acetylene and propadiene have been reduced to levels less than 30 ppm. and under some process conditions have been converted almost quantitatively to propylene upping production from 1-3%.

ACS On The Campus

Three science lectures were delivered May 28 and 29 before the Michigan State University chapter of the American Chemical Society by Dr. Henry Eyring, professor of chemistry and dean of the graduate school at the University of Utah. For the second year, this annual lectureship was sponsored by the Renaud Foundation, the philanthropic agency of Ren Plastics, Inc.

Dr. Eyring is noted for having developed: a method of calculating chemical reaction rates from theory; a theory of liquids; a theory of flames; and for his applications of quantum mechanics in chemistry. His lectures to M.S.U. students and faculty members were entitled: "Significant Structures in the Liquid State," "Ions in Flames," and "Relaxation Theory of Plastic Flow."

Names in the News

Adrian H. Cubberley

Adrian H. Cubberley has been named coordinator of chemicals, research and development department, for Allied Chemical Corp's plastics and coal chemicals division. He will be responsible for development and liaison between sales, manufacturing, and the research department.

Neil F. Putnam has been elected vice president in charge of engineering at Improved Machinery, Inc. He joined the firm in 1935 as a draftsman, and most recently served as manager of engineering.

Frank A. Magno has been named assistant sales manager, Eastern region, for Godfrey L. Cabot, Inc. He previously served as sales-service representative for the Midwestern area of special blacks department.

Paul V. Brown has been appointed manager of manufacturing at the La Verne, Calif., plant of Taylor Fibre Co. He previously served as technical director of Fabricon Products and as chief chemist for the Richardson Co.

Robert C. Doban, supervisor of the research and development laboratory for Du Pont's polychemicals department, has been transferred from the experimental station to the corresponding laboratory at the Washington Works, Parkersburg, W. Va. He will continue to direct research on development of applications for Teflon resins.

Raymond J. Vonesh has been named executive secretary for the Rubber & Plastic Adhesive & Sealant Manufacturers Council, which has established a new headquarters in Chicago, Ill. He will also continue in his duties as executive secretary of the Chicago Paint, Varnish & Lacquer Assn.

Aimison Jonnard has been appointed assistant manager of polymer planning and applications at U. S. Industrial Chemicals Co. He will be responsible for market analysis and applications development. Mr. Jonnard previously served as manager of Shell Chemical's chemical market analysis department.

Kenneth A. Erwin

Kenneth A. Erwin has been appointed administrative manager of research & development for the Marbon Chemical division of Borg-Warner Corp. For the past 11 years Mr. Erwin had been a G-E associate, serving in laboratory, administrative, and engineering capacities. He is a past national director of the Society of Plastics Engineers.

Edgar E. Wrege has been appointed operations manager, special products division, for Avisco Film—a subsidiary of American Viscose Corp. Products include cellulose bands, meat casings, plastic molding powders, and other special items. Dr. Wrege first joined the firm in 1954 as leader of the experimental engineering section.

William E. Morris

William E. Morris has been appointed product supervisor for Plaskon phenolic resins for Allied Chemical's plastics & coal chemicals division. He has been with the firm's Edgewater laboratories since 1951, serving most recently as group leader of the resin application laboratory.

W. C. Goggin

Frank J. MacRae

Frank J. MacRae has been appointed manager of plastics technical service for Dow Chemical Co. He was one of the first Dow plastics engineers and chemists, and has been assistant manager for the last seven years. Mr. Macrae replaces **W. C. Goggin** who, in turn, succeeds C. B. Branch as manager of Dow's plastics department. Mr. Branch is now manager of all Dow overseas activities outside the North American continent.

William J. Parmley has been appointed works manager for the Kenton, O., plant of Hooker Chemical's Durez Plastics division. A Durez employe since 1943, he has been plant superintendent for the past year.

Ed J. Lynch has been appointed sales representative for Davis-Standard, division of Franklin Research Corp., in California, Oregon, and Washington. The firm manufactures extruders and wire line machinery.

William P. Hahn has been appointed to the newly-created post of technical manager for Johns-Manville Fiber Glass, Inc. He will have direct supervision of product planning from headquarters in Toledo, O. A J-M employe since 1936, he had been serving as assistant manager of industrial insulations research.

Henry B. Puff has been appointed assistant product manager, resins, for Hooker Chemical Corp.'s Durez Plastics division. He is succeeded as district sales manager in Chicago by **Edwin E. Woodman.**

Richard D. Wells, assistant director of Fabric Research Laboratories, Inc., has been given a six-month leave of absence to devote full time to Air Reduction Chemical Co., polyvinyl alcohol fiber program. Mr. Wells had been working on technical and market studies of vinylon fiber (made in Japan from polyvinyl alcohol resin), and the accelerated pace of the program necessitated his full-time attention in New York.

Names in the News (Cont'd.)

Nathaniel Willis has joined the Richardson Co., and is assigned to the technical development department, applications section. A former Bee Chemical employe, Mr. Willis will be concerned with the "use" aspects of new products.

Edgar E. Hardy has been appointed an associate in the development department of Monsanto Chemical Co.'s plastics division, Springfield, Mass. Dr. Hardy previously served as director of research for Mobay Chemical Co.

Arthur B. Steele has been appointed director of Union Carbide Chemicals Corp's technical service laboratory, in addition to his present duties as tech service manager. A Carbide associate since 1941, Dr. Steele will maintain headquarters at the new laboratory which is currently being built in Westchester County, N. Y.

E. K. Hunt

H. C. Milton

E. K. Hunt has been appointed to the newly-created post of merchandising manager for American Cyanamid's plastics & resins division. He is succeeded as sales manager by **H. C. Milton,** former manager of the process chemicals department, industrial chemicals division. Mr. Hunt had been public relations manager, and advertising manager for the Calco chemicals, organic chemicals, and pigments divisions.

A. S. Pollock has been appointed plant manager of the organic coatings division, Metal & Thermit Corp. He previously served as superinendent of organic coatings and process engineering for the firm.

Robert E. Lally has been appointed manager of Metasap Laboratories, and will be responsible for research, development, and technical service concerned with metallic soap and vinyl stabilizer applications. Mr. Lally joined the parent firm, Nopco Chemical, after 16 years with Ferro Chemical and Chas. Pfizer & Co.

J. W. L. Fordham has been appointed manager of the research and development department for Diamond Alkali's plastics division, and will maintain headquarters in Cleveland. He comes to the division from Diamond's central research department in Painesville, O.

Clarence Hammer, supervisor in the research and development department of Du Pont's polychemicals department at the experimental station near Wilmington, has been transferred to the linear polyethylene plant at Orange, Tex. Dr. Hammer will head up a research group which will be concerned with special studies. He joined the firm in 1948 as a research physicist, and has been concerned with development work on Alathons and Zytels.

J. Franklin Everett has been appointed manager of closure technical service at Armstrong Cork Co.'s research and development center, Lancaster, Pa. He succeeds the late **Joseph A. Benner,** who had served in that capacity since 1944. Mr. Everett joined the firm in 1952 as a chemist in that department.

R. W. Matthews has been named marketing manager, vinyl foam division, Union Carbide Plastics Co. He will be responsible for the promotion and marketing of vinyl foam, and will work out of the Newark, N. J., offices. Mr. Matthews joined the firm in 1932, and has served as director of exhibits, sales promotion manager, and manager of publicity and presentations.

H. W. Saunders, district manager and vice president in charge of the San Francisco district for Air Reduction Pacific Co., has retired after 41 years of service. He is succeeded by **L. A. Hamilton,** vice president in charge of the Seattle, Wash., district.

David K. Eads

David K. Eads has been named supervisor of the chemical engineering process development section of Foster Grant's research laboratories. Dr. Eads formerly was associated with Callery Chemical Co. and Mellon Institute.

Donald T. Wynne, Jr

Granville H. Shirley

Donald T. Wynne, Jr., has been named division manager in charge of all plastics operations for Vlchek Tool Co., Cleveland, O. A former associate of International Molded Plastics and Clevite Corp., Mr. Wynne had been serving as assistant plastics divisional manager for the past year. **Granville H. Shirley** is the new plastics division sales manager, and new district manager for the Ohio area is **Forest E. Wall.** Mr. Shirley previously was employed by VanDorn Iron Works and Diamond Alkali Co., and Mr. Wall had been sales manager of Kurz Kasch, Inc.

OBITUARY

John E. Stokes

John E. Stokes, 51, central zone manager for laminating materials, Union Carbide Plastics Co., died suddenly of a heart attack on April 17. A resident of Bay Village, O., Mr. Stokes worked out of the Cleveland office. He was past chairman of the reinforced plastics division, Society of the Plastics Industry, and an honorary member of the SPI executive board. He also held membership in the Society of Plastics Engineers.

Mr. Stokes was born December 16, 1906, at Avalon, Pa. He attended the University of Pittsburgh, University of Michigan, and Carnegie Institute of Technology. He joined Bakelite in 1943 as a technical representative.

John B. Hendrickson

John B. Hendrickson, founder and chairman of the board of Welding Engineers, Inc., died May 1 at Chestnut Hill Hospital, Philadelphia. The inventor and holder of numerous patents, Mr. Hendrickson pioneered the dual worm method of plastics processing. He was an alumnus of Cornell University, and resided at West Valley Green Road, Whitemarsh.

Initially, Mr. Hendrickson's company did specialty work in welding in the Philadelphia area. In the early 1940's, the company began moving operations to its present location in Upper Merion Township, Greater Delaware Valley. An associate company, Dominion Welding Engineering, Ltd., was set up in Canada.

Mr. Hendrickson is survived by his wife, Estella; a son, John G.; and two brothers. Services were held at St. Martin-in-the-Fields, Chestnut Hill, with interment at George Washington Memorial Park, Whitemarsh.

New Materials

Write item numbers on Readers' Service Card (p. 95) to obtain more information.

Modifier For PVC Plastisols

Monomer X-970, a high boiling, low viscosity ester which can be polymerized by heating or by catalysis to a cross-linked, thermoset polymer, is available in experimental quantities from Rohm & Haas Co. Used as a modifier for PVC plastisols, it imparts fluidity to the plastisol, yet polymerizes, during the normal fluxing cycle, to a hard, thermosetting, insoluble compatible polymer.

Ideally suited for use in rotocasting and other closed mold applications, Monomer X-970 gives harder castings than can be obtained with conventional formulations at low plasticizer content and of equal fluidity. In addition, these castings exhibit a reduced tendency to deform under heat.

Monomer X-970 is inhibited to prevent polymerization during shipping and storage. Its predicted stability at 25° C. ranges up to several years, although polymerization will start after approximately 50 hours at 100° C. Typical properties include:

Purity, %	98.9
Specific gravity, 25° C.	1.011
Refractive index, 25° C.	1.4502
Color, APHA	50
Water, %	0.1

Readers' Service Item 1

Textile Form Graphite

Organic textile forms are being converted directly to graphite with a purity in excess of 99.9% by National Carbon Co., a division of Union Carbide Corp. Rayon yarns, braids, felts, and fabrics, are heated electrically to a temperature approaching 5,400° F. to effect a conversion of the crystalline structure of the material.

Graphite textiles are resistant to attack by acids, alkalies, and organic compounds, except for those of a highly oxidizing nature, and are unreactive with many molten metals. They have excellent electrical and thermal conductivity and, being in flexible form, are immune to thermal shock.

A versatile material, graphite cloth is being used experimentally for various plastics and refractory materials used in high temperature applications. Its chemical resistance recommends its use in bag-type filters for hot non-oxidizing gases; for equipment to handle corrosive fluids; in electrostatic precipitators; curtain walls; and flame arrestors.

Although most graphite textiles have less than 0.1% ash, for special purposes graphite textile forms of spectroscopic purity can be made. Some properties of graphite cloth, square weave, 28 by 28 construction, include: typical surface area, 260 square feet per square foot; weight per square foot, 0.04 pounds; tensile strength at room temperature, 10-15 pounds per inch width; electrical resistance at room temperature, 0.5 ohm per inch width per inch length; typical ash analysis, 0.09%.

Readers' Service Item 2

Multi-Purpose Epoxy Resins

A multi-purpose, liquid epoxy resin, available in two formulations, is being marketed by Marblette Corp. Recommended for casting, laminating, and adhesive uses where high heat resistance is required, Resin 617-A is aluminum filled while Resin 617-C is clear. Both have a low viscosity which can be maintained at room temperature for as long as 30 minutes, even after mixture with a hardener.

Both formulations can be used at operating temperatures as high as 500° F. Heat distortion point is 425° F., and beyond that temperature the compounds retain their elasticity rather than tending to break. Maximum deformation of 0.01 in./in., is partially recoverable. In adhesive applications a shear strength on an aluminum to aluminum bond at 400° F., of 1,380 psi. is obtained. Other properties include:

Cast Resin	
Tensile strength, psi.:	
77° F.	10,700
300° F.	4,500
Shrinkage, in./in.	0.0025
Laminating Resin—12 plies, 181 Volan A	
Flexural strength, psi.:	
400° F.	41,000
500° F.	22,000

Readers' Service Item 3

Sponge Teflon

Sponge Teflon in a variety of pore sizes and void contents for use in filtration, electronic, and mechanical applications has been developed by Liquid Nitrogen Processing Corp. First introduced approximately five years ago, this material has been under development since that time and now is commercially available in pore sizes of 5-50 microns and void contents of 5-55%. These properties can be varied independently.

As a filter, Teflon offers inertness to all chemicals, solvents, bacteria, fungus, and most oxidizing agents at temperatures between —400 and 500° F. The pores are interconnected to make an integrated network of air cells. Its low dielectric loss and uniformity at various humidities and temperatures point to applications both as an electric and thermal insulator for ultra-high frequency equipment.

Special grades can be prepared by introducing various reinforcing or modifying agents such as carbon, graphite, glass, quartz, and metals. In nuclear applications, fillers such as calcium fluoride or boron compounds could be added to reduce nuclear degradation. Typical properties for grade LNP 30-40 are:

Pore size, microns, max.*	90
Average	25
Voids, %	55
Density	0.097
Hardness, Durometer D	16
Flow rate, water, gpm./sq.ft.:	
10 psi.	9
25 psi.	15
Air, cfm./sq.ft., 7 psi.	400
Thermal conductivity x 10-4, cal./cm./cm.²/sec./° C.	4.5
Expansion x 10-5, in./in./°C. (40-290° C)	14.0
Heat of distortion, 66, psi., °F.	236
Dielectric constant, 1 KC	1.40
Factor	<0.0001

* Values represent intial product passing through a freshly installed sheet. Values at higher pressures are proportionately smaller due to compression.

Readers' Service Item 4

Silicone Potting Compound

A silicone potting compound which permits visual and instrument checking of individual parts within a potted assembly, is available for experimental evaluation from Dow Corning Corp. Designated Dow Corning XF 1-0042, this water-white liquid is about as viscous as molasses, and must be catalyzed and deaerated before using. It surrounds the components readily, and cures in place to form a resilient mass which combines outstanding dielectric properties with thermal stability and moisture resistance.

Typical properties of the uncured resin include:

Viscosity, 25°C., centistokes	700
Flash point, °F	—58
Freezing point, °F	—58
Refractive index, 25° C.	1.40
Specific gravity, 25° C.	0.970
Pounds/gal.	8
Volatility, % weight loss after 4 hrs. at 250° C.	0.53

Since this dielectric gel remains water-white after cure, circuit components can be located visually and checked by inserting test probes. When the probes are removed, the gel completely reseals itself.

XF 1-0042 is catalyzed by mixing 10 parts by weight of catalyst into 100 parts

of fluid. Consistency of the cured material can be altered by varying the amount of catalyst to between nine and 12 parts per hundred. Recommended cure temperatures range from 40-150° C. At the lower temperature, time required is 48 hours, at the higher temperature, 30 minutes to one hour. Curing above or below these temperatures is not recommended.

Extended high temperature exposure hardens and increases the friability of the gel, although dielectric properties are retained. Although service life at elevated temperatures is still being determined, data gathered so far indicate a 1,000 hour operational life at temperatures between 150-200° C. At temperatures below this, up to 5,000 hours can be anticipated.

Since XF 1-0042 is offered for experimental evaluation only, its properites may be changed to increase its utility when further data are acquired. At present, typical properties of the cured gel include:

Coefficient of thermal conductivity, cal./cm./°C./sec.:	
150° C.	0.00070
200° C.	0.00078
Dielectric constant, 100 cps.—0.1 Megacycle:	
23° C.	3.0
150° C.	2.55
Dissipation faction, 100 cps.:	
23° C.	0.0001
150° C.	0.002
0.1 Megacycle:	
23° C.	0.0001
150° C.	0.0002
Volume resistivity, ohm-cm.:	
23° C.	5×10^{14}
150° C.	1×10^{14}

Readers' Service Item 5

Phenol-Formaldehyde Resin

A bromo-alkylated, phenol-formaldehyde resin which reduces the cure time of butyl rubber and provides improved its heat resistance and compression set properties, has been announced by Schenectady Varnish Co., Inc. Identified as SP-1055 Resin, this material needs no catalyst to effect the cure.

Butyl rubber parts, capable of withstanding exposure to temperatures up to 500° F. without losing their resiliency can be made. The resin gives a safe scorch range for wide process application. Properly compounded, SP-1055 Resin provides tack to butyl rubber, thus making it possible to assemble complex articles and lower production rejects. It may be added to the compound either on the mill or in the Banbury. Typical properties include:

Specific gravity	1.06
Melting point, capillary, °F	124
Color, U.S.D.A. Rosin Standard	K
Moisture content, %	0.12
Ash, %	0.025

Readers' Service Item 6

Amino-Functional Silane

An amino-functional silane, which will couple organic and inorganic materials together, has been developed and placed on the market by Dow Corning Corp. Identified as Dow Corning Z-6020, its molecule contains primary and secondary amine groups which will combine with phenolics, epoxy, or melamine resins, organic adhesives, and common dyes. When dissolved in water, hydroxyl groups form on the silicon atom, and these attach to inorganic materials such as glass, minerals, or metals.

A brown liquid, having a viscosity of about 5-15 centistokes and a specific gravity ranging from 1.03-1.06 at 25° C., Z-6020 can be used for bonding resins to glass fibers in molding compounds; coupling resins and inorganic materials together in making brake linings, shell moldings, and grinding wheels; bonding abrasives to backing paper more securely; increasing the adhesion between asphalt binders and stone aggregate; and in making stronger adhesives for use under humid conditions.

For dispersions—pigments, cements, clays, and metallic oxides can be slurried in a 0.1-0.5% aqueous solution of Z-6020. The silane prevents agglomeration of the particles by forming a monomolecular film around them. It can be used also as an epoxy curing agent, a dyeing aid, as a binder for glass and mineral wool insulation, and as a coupling agent between glass cloth and organic resins.

Completely soluble in water and most other common solvents, Z-6020 must be applied to clean dry surfaces. It has a shelf life in excess of eight months and is packaged in containers of 8.5, 42.5, and 450 pounds net weight.

Readers' Service Item 7

Polyester Molding Compound

A glass-reinforced, polyester molding compound, designated Thermaflow 105, has been added to the product line of Atlas Powder Co. Intended as a general purpose molding compound, this material has ample chemical resistance as well as sufficient flexural and impact strengths for most uses, and costs about 20% less than compounds of similar quality.

Molded parts are reported to have exceptionally uniform physical properties throughout. Typical processing conditions are: 400-800 psi. at about 300° F. for compression molding; and 500-1,500 psi. at about 315° F. for transfer. Cure time for a 1/16-inch section at 300° is about 40 seconds, and for a 1/8-inch section about 1.25 minutes. Medium to fast closing speeds are recommended.

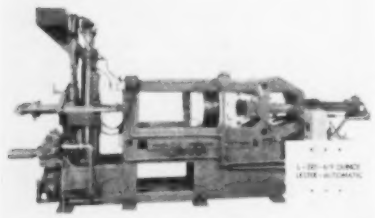
Thermaflow 105 is resistant to concentrated alkali, dilute acids, and organic solvents. Its heat distortion point is greater than 450° F. and electrical properties are comparable to those of most high quality molding compounds. Although supplied in a standard gray, it can be obtained in a variety of other colors if desired. Typical properties include:

Specific gravity	1.87
Flexural strength, psi.:	
A.S.T.M. bar	20,000
Cut specimen	16,000
Flexural modulus, psi, x 10^6	1.6
Izod impact, ft-lbs./in. notch:	
A.S.T.M. bar	12
Cut specimen	4.5
Tensile strength, psi	6,500
Compressive strength, psi	18,000
Heat distortion point, 264 psi., °F	450
Hardness, Barcol	65
Water absorption, %:	
24 hrs. to 23° C.	0.14
At 100° C.	0.75
Mold shrinkage, in./in.:	
Compression	0.001
Transfer	0.003-0.004
Dielectric constant, 1 megacycle	5.05
Dissipation factor, 1 megacycle	0.009

Readers' Service Item 8

New Equipment

Write item numbers on Readers' Service Card (p. 95) to obtain more information.



Lester-Automatic L-225-6/9 ounce injection molder.

6/9 Ounce Injection Machine

An automatic injection molding machine, designed for general purpose work in the six to nine ounce range, has been introduced by Lester-Phoenix, Inc. Designated model L-225-6/9 Lester Ejector Molding Machine, this unit is equipped with three die height spacer rings so that a variety of mold sizes can be accommodated.

Although designed for a nine-ounce shot on double feed, Model L-225-6/9 will handle up to 12 ounces of styrene. It is adaptable for nylon molding when fitted with a special cut-off attachment. Stroke can be adjusted from 16-8 inches, with a total daylight opening of 38 inches. Dry cycle time for the eight-inch stroke is four seconds; for the 16-inch stroke, five seconds. The plasticizer is electrically heated and, using polystyrene, will handle up to 150 pounds per hour. Injection cylinder retracts 12 inches for purging and maintenance. Standard features include: 2,000 psi. pressure system; SPI standard ejection; panel-mounted valving; low pressure closing; and automatic cycling. Operational characteristics are as follows:

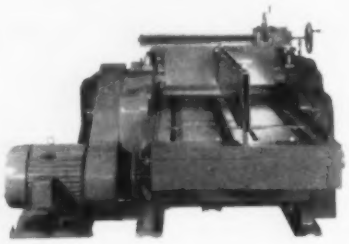
Plunger displacement, in.³	23.4
Injection plunger dia., in.	2.3125
Oil plunger cylinder dia., in.	7.25
Total force on injection plunger, lbs.	82,500
Injection plunger stroke, in.	7.5
Speed, rapid advance, in./min.	375
During final fill, in./min.	188
Complete injection stroke, sec.	1.2
Mold closing pressure, tons	225
Total beam area, in.²	90
Mold opening and closing time, sec. (8-inch movement)	1.3
(16-inch movement) sec.	2.2
Feed hopper capacity, lbs.	50
Total band heating units, kw.	12.4
Internal heater, kw.	2.3
Combined pump cap. at 2,000 psi., gpm.	32.7
Oil reservoir cap., gal.	80
Motor hp.	30
Speed, rpm.	1,200
Foundation space, ft.²	35
Approximate weight, lbs.	18,500

Readers' Service Item 21

High Speed Sizer

Buss Machine Works has introduced a high speed sizing machine whose cutter speeds are so fast that even thermoplastics can be machined without melting them. An addition to the company's Micro-Surfacer line, this unit can handle sheets up to 54 inches wide at speeds of nearly 300 feet per minute.

Stock is fed through the machine by means of drag chains and pusher rails, although when thin stock is processed, the drag chains are replaced by a conveyor and roll feed. As the stock enters, it is engaged by pressure rolls and shoes which hold it while the cutter head makes its pass. The cutter rotates at 5,000 rpm. and carries six tungsten carbide knives. Position of the bed, which can be raised or lowered, determines the amount of material which is removed. This cutter can be equipped with motors up to 50 hp.



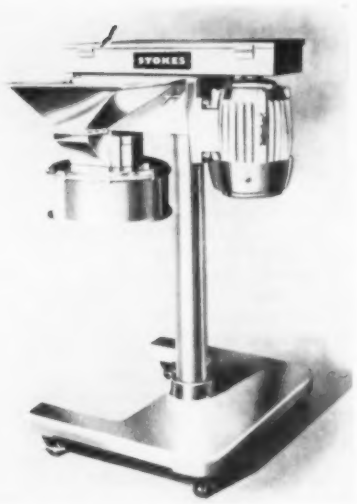
Buss Machine Works' Micro-Surfacer.

Readers' Service Item 22

High-Speed Granulator

A granulating and mixing machine, called the Tornado mill, which features 360° of screening area, has been made available by F. J. Stokes Corp. Currently available in three sizes, this machine grinds and mixes the material with a series of fast-moving blades. An induced air-flow throws the mix at high velocity against the cylindrical mesh screen surrounding the rotor. The material is reduced to a uniform particle size, without excessive fines.

Streak-free color blending of two or more pigments, or of pigment and plastic can be accomplished. Rotor blades are made of stainless steel as are all parts



Stokes Tornado mill.

which come in contact with the material being processed. The blades can be replaced in minutes, if necessary. The drive motor and grinding head are balanced on a cross beam which is supported on a vertical column. Grinding speed can be varied by selection from three reduction ratios offered by step-pulleys on the motor and grinder. Belts are totally enclosed for safety. Other characteristics include:

	Model 44-0	Model 44-1
Horsepower	5	25
Rotor diameter, in.	10	12
Screen area, in.²	160	270
Number of knives	14	16
Electrical service, volts	220	220
Net weight, lbs.	400	750
Height, over-all, in.	57	*
Base dimensions, in.	36x34	*

* Variable, to suit requirements.

Readers' Service Item 23

Urethane Foaming Machines

Five types of portable machines for automatic metering and mixing of polyurethane foams have been placed on the market by American Latex Products Corp.

The P Series delivers 5-15 to 40-80 pounds of foam per minute, depending on the model, and incorporates a continuous pour head arranged for either fixed or portable remote operation. It is mounted in a steel cabinet, and weighs between 500-600 pounds.

C Series discharges 2-6 to 5-15 pounds of foam per minute. Pour heads are arranged for portable, remote operation. These models are mounted on a wheeled base-plate, and weigh between 250-300 pounds.

The R Series has an on-off recirculating head for intermittent molding of relatively small parts. Volume is metered by time

settings, and foam delivery ranges from 0.5-1.5 to 5-10 pounds per minute. This type is mounted in a steel cabinet and weighs between 500-550 pounds.

SM Series is for laboratory use. Foam deliveries range from 2-5 to 5-10 pounds per minute. Heads are designed for on-off recirculation, and volume is metered by time settings. This type weighs about 600 pounds and is particularly suited for testing materials.

The B Series are built to customer specifications. They use an injection type catalyst pump with a continuous pour head, and can deliver catalyst-resin mixtures at rates up to 250 pounds per minute.

Specifications common to all models include: dimensions in inches, height 70, width 38, and depth 32; ratio limits, 11.07:1 to 2:1; maximum viscosity, 20,000 cps.; compressed air requirements, 80-100 psig.; resin and catalyst flow is varied by gear changes, except in the Models SM which use a variable drive for the catalyst. Power requirements, 220 volt A.C., single phase, 60 cycle, except in models P40B and P80B, which require three-phase.

American Latex's Model SM urethane foam mixer.

Readers' Service Item 24

End-Loading, Drum Tumbler

An automatic drum tumbler, featuring end-loading and unloading, is available from Ransohoff, Inc. The unit incorporates a power loader which dumps the parts into the loading hopper of the machine from which they are fed to a heavy

If you have a ***Plasticizer*** *problem requiring a* ***Polymeric,*** *we have a solution for you.....*

it's **HARFLEX 330**

Typical questions asked of our Laboratory:

PROBLEM: Our vinyl gaskets always met the requirements of the refrigerator manufacturers, but recently the odor restrictions have been tightened. What do you have that might help?
ANSWER: Our new HARFLEX 330. This is an improvement on our Harflex 325 which has satisfied all requirements to date. HARFLEX 330 has exceptionally low odor and taste transfer. Its resistance to migration into polystyrene is also good. For a polymeric, it has good low temperature properties.

PROBLEM: We are manufacturers of automobile crash pad film. We understand you have a good polymeric plasticizer that would not contribute to window "fogging."
ANSWER: Correct. Our new HARFLEX 330 has low volatility, is compatible with epoxy plasticizers of low volatility and does not exude under high humidity conditions or high temperatures. Tests show it to be suited ideally for this purpose.

PROBLEM: We need a good, reasonably priced, permanent plasticizer for various electrical applications.
ANSWER: HARFLEX 330 is the best for your purpose. It has good electrical properties and has high dielectric strength both in dry compounds and after immersion in water.

HARFLEX 330 is close to being the ideal polymeric plasticizer. In addition to the above features, it has good resistance to migration into lacquers and varnishes and also to extraction by water, soapy water, oil and gasoline.

The best way to solve your problem is to test a sample. Why not write for one? Address Dept. M-60.73

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HARCHEM DIVISION

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IN CANADA: W. C. HARDESTY CO. OF CANADA, LTD., TORONTO

IF IT'S FREE FLOWING AND DRY

we have accurate reliable means of feeding it. For information about these dry chemical feeders *both gravimetric and volumetric...*

Write Dept. M-42.73

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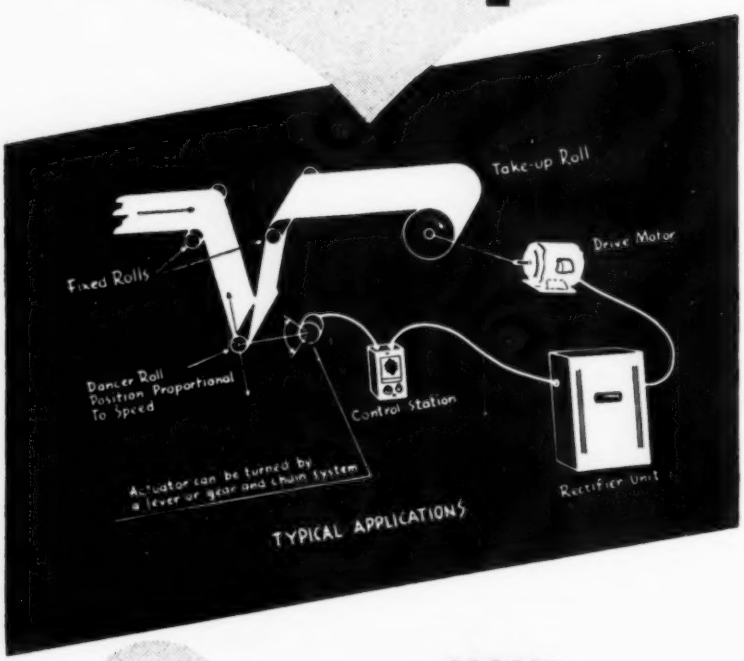
Automatic
Take-Up



Here's HOW IT WORKS ...for Textile and Plastics Processing

A small tension change positions the actuator shaft so as to call for motor speed change to restore preset tension. Thus a constant linear feet per minute windup may be achieved even though the radius of takeup roll increases with each turn to otherwise increase linear speed versus radius build-up. Speed is now made proportional to position of dancer roll and tension is held essentially constant, as is the linear rate of material travel.

These and other models of electronic motor speed control systems available from 1/50th to 2 horsepower.

WRITE

Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave. Paterson, N. J.

duty wire mesh drum. Parts are held in the drum by a retaining head.

After the flashings are removed, they are separated automatically by falling through the mesh openings of the drum. A chute under the drum diverts the flashings to collection boxes for periodic disposal. After the tumbling cycle, the drum stops rotating, and reverses its direction to unload.

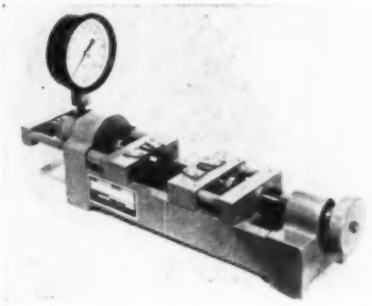
Design is flexible and the machine can be adapted to meet specific space, processing, and work requirements. The drum is hooded to retain dust, and a timing device is provided so that uniform cycles can be set up.

Readers' Service Item 25

Portable Tensile Testers

A series of portable tensile testing machines, available with capacities ranging from 100-1,000 psi., has been introduced by Steel City Testing Machines, Inc. Identified as the Models THM, these units weigh only 36 pounds and can accommodate either flat or round specimens.

Load, applied manually by rotating a knurled knob, is measured by a trapped-oil system. Interchangeable, wedge-type jaws are used for holding flat or cylindrical objects during tests. Three jaw sizes are



Steel City Testing Machine's Model THM-600.

available for holding flat specimen thicknesses up to ⅜-inch; and three for holding round objects with diameters from ⅛-⅝-inch. Maximum length of test specimens is seven inches.

The gages are 4½ inches in diameter, and are graduated in increments ranging from ½-pound on the 100 psi. model to five pounds for the 1,000 psi. unit. Overall dimensions in inches are: width, 5; length, 23; and height, 11.

Readers' Service Item 26

RIGID or FLEXIBLE...

URETHANE FOAMS PERFORM BETTER, LAST LONGER WITH WITCO FOMREZ® RESINS

Top-quality urethane foams are a natural with Witco's new Fomrez resins. Adaptable to a wide range of foam densities, they are easy to handle and outstandingly uniform, insuring the highest degree of batch-to-batch reproducibility. There's a Witco resin for every type of foam, both flexible and rigid. Mail coupon for details.

FOR FLEXIBLE FOAMS

Witco Fomrez No. 50... Witco Fomrez No. 70

For the production of high-quality flexible urethane foams, adaptable to both "one-shot" and prepolymer foaming systems. Widely applicable in industries such as automotive, aviation, furniture, clothing, packaging, bedding, sports equipment, and many others.

FOR RIGID FOAMS

Witco Fomrez R-400... Witco Fomrez P-420

Foaming systems for producing low to high density rigid foams possessing excellent structural strength, uniform cell structure, heat and dimensional stability. Can be foamed in-place by batch, continuous or intermittent machine-mixing or spray-foaming methods. *Rigid foam uses:* thermal insulation (refrigerators, freezers, pipes, tanks, etc.); structural reinforcements (core material for structural sandwich panels, wall panels, etc.); potting or encapsulation of electric components; flotation equipment.

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A report on Oronite Isophthalic

OPERATION "UPGRADE"

in the plastics industry

Oronite Isophthalic is well on its way as a significant new raw material for the plastics industry. The primary reasons for this are:

1. It is an aromatic dibasic acid derived from plentiful, low-cost petrochemical sources and is available in multi-million pound quantities.

2. It has been proven successful and shows great promise in saturated and unsaturated polyesters, polyamides, polyesters-amides, polyester-urethanes and copolymers.

3. Superior products are now being produced with Oronite Isophthalic in many fields; reinforced plastics, thermoset and thermoplastic molding compounds, films, fibers, foamed cellular materials, elastomers, plasticizers, plastisols, adhesives and coatings.

4. In most cases Isophthalic based materials require no special handling in their production and their performance qualities approach or surpass higher cost materials.

5. Oronite, the only experienced producer of Isophthalic, is able to supply the plastics maker technical assistance to convert Isophthalic into materials for his individual requirements.

FOR BULLETIN "Oronite Isophthalic—Key to Superior Plastic Products", address inquiry to Oronite's executive offices, San Francisco.

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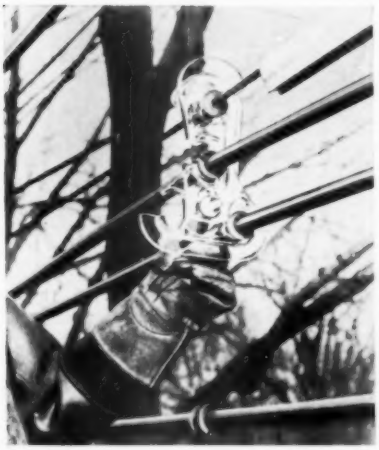
5547

Plastics Applications

Write item numbers on Readers' Service Card (p. 95) to obtain more information.



Acrylic clamp for power cables.

Molded Acrylic Cable Clamp

A molded acrylic device for suspending high-voltage power cables called the Roeclamp is available from John A. Roebling's Sons Corp. Intended to simplify the operation of running the cables through dense tree areas, the clamp offers 60% savings over conventional self-supporting RR cable systems of equivalent current-carrying capacity.

Easy to open and easy to close, the Roeclamp is molded in two intermatching sections by Chicago Molded Products Corp. The firm also injection molds a nut and bolt out of the same methyl methacrylate material. In operation, the Roeclamp is fastened through its uppermost opening (narrow end up) to the "messenger" or supporting cable. A sized-to-fit grommet placed over the wire prevents the clamp from slipping or sliding. In running power lines outdoors, the messenger cable is suspended above the conductors (power carrying lines) and bears the weight load of the entire cable suspension system.

With the device, three separate power (phase) lines can be carried at one time, each independent of the other. The Roeclamp has three holding positions, each capable of suspending a 5-kv rated cable. A clearance through treed sections of one foot in diameter is all that is required, as compared with the 8-10 foot holes which must be cut to permit passage of regular open-wire lines.

Readers' Service Item 41

Hydro-Jet Vacuum Cleaner

A vacuum cleaner with brush for cleaning plastic swimming or wading pools is available from Poolmaster, Inc. Called the Model J-7 Junior Jet, the unit is injection molded of Eastman's Tenite butyrate by Kennerley-Spratling, Inc. The removable hose coupling is molded by Arant & Co., Inc. Total weight is a mere three pounds.

The cam-locking, swivel hose coupling at the top permits the unit to be adapted for optional use as a suction vacuum with plastic pool hose. For jet operation, a filter bag ties down over the retainer ring at center. Power is supplied by water pressure from a garden hose, which can be attached just beneath the handle bracket. As it is pulled back and forth over the pool bottom, debris is sucked through the eight-inch head into the filter bag.

The bracket accommodates most standard 1¼-inch O.D. aluminum handles, the same diameter as most hose. A modified unit with wheels is available for use with concrete and other hard-surfaced pools. Color is aquamarine.

Butyrate pool cleaner sans handle and bag.

Readers' Service Item 42

High-Density Polyethylene Tub

One of the largest high-density polyethylene moldings to date is the baby tub introduced recently by Baby Bathinette Corp. Called the Lifetime Tub, it is molded from W. R. Grace's Grex material. Lightweight, yet sturdy, the tub is designed to fit all frames made by the firm plus those of most other manufacturers.

Grex high-density polyethylene tub.

Dressing-table features of the tub remain unimpaired when it is removed from the frame. The tub, therefore, can be used for bathing on any flat surface in kitchen, nursery, or bathroom. As the baby outgrows the tub, it can be pressed into service as a laundry basket, tote box, or the like.

Readers' Service Item 43

Polyethylene Glove Cabinets

A low-cost "glove compartment" for manipulating radioactive material and equipment has been placed on the market by Torsion Balance Co. The top is clear polyethylene (for good visibility), and the more flexible, plastic-zippered bottom is standard milky polyethylene sheet. A plated steel-rod frame supports both the main chamber and air lock.

All seams and the plastic gloves are welded by special high-frequency heat sealing units. The molded zipper encircles both sides of the cabinet, permitting easy access so that base trays, retort stands, and any large apparatus can be placed and adjusted without using the gloves and air lock. Materials for operation are inserted through this lock which has similar closures on the inlet and outlet walls.

Inlets are provided for inflating both the main chamber and airlock separately, and a differential pressure can be maintained between the two if required, so that leakage into the main chamber can-

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Polyethylene radiation chamber.

not occur when the air lock is opened. The cabinet measures 22½ by 24 inches and the height, from front to back, ranges from 2 to 21 inches. The air lock chamber is 8 by 12 by 21 inches.

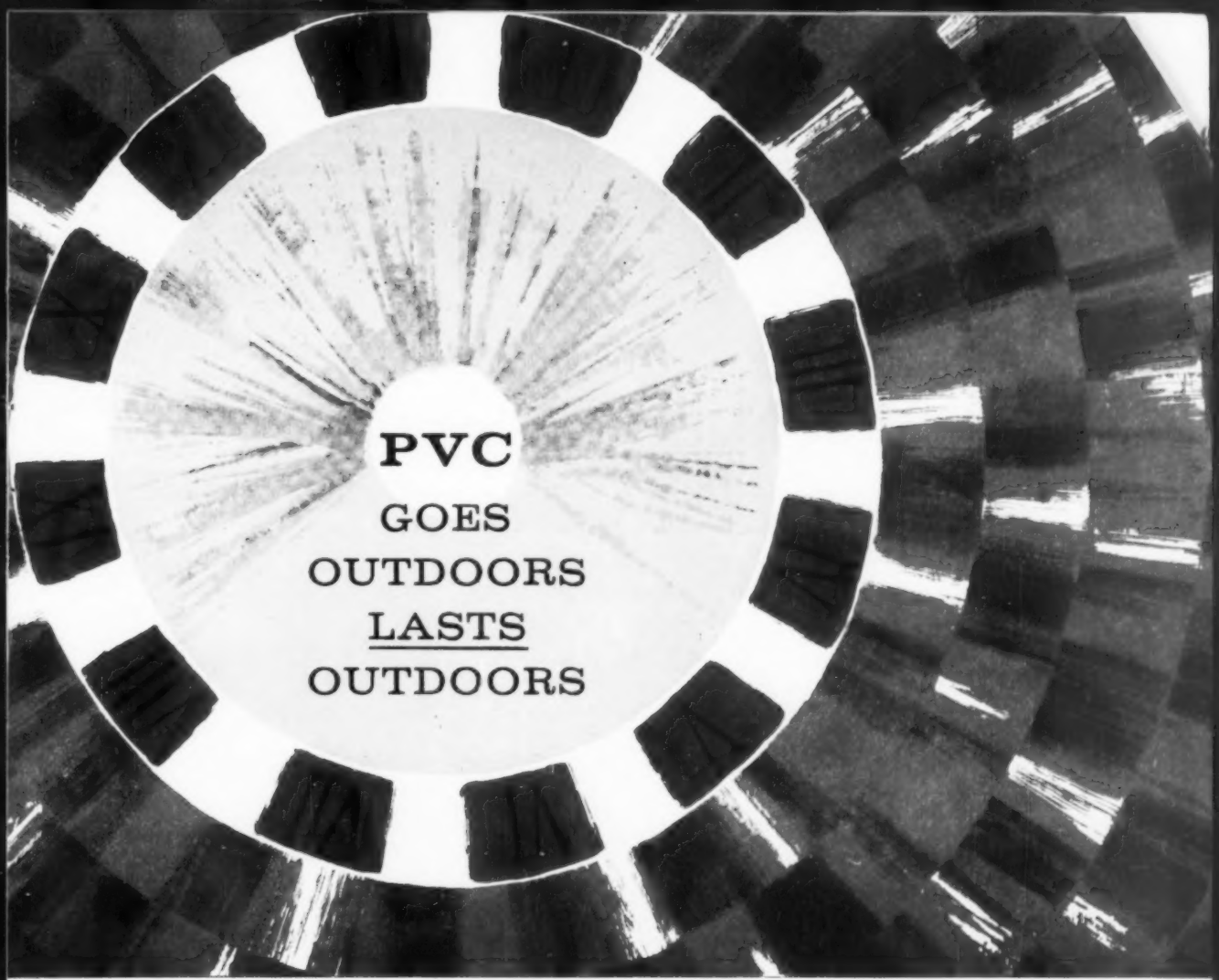
Readers' Service Item 44

All-Plastic Syntactic Core

Mobjack Mfg. Co. has come up with a new structural concept for the construction of sail boat hulls. It involves the use of Syncore, a low density syntactic core construction of Bakelite phenolic spheres, Dynel (acrylic fiber) flock, and polyester resin blends. This combination is said to give better performance than conventional polyester-glass laminates, and the Dynel flock allows a better weight-stiffness ratio.

In addition to the hull, Syncore is used

Mobjack sloop with all-plastic core. Inset shows the core in cross section.



protected by **CYASORB*** Light Absorbers . . . sun up to sun down

Polyvinyl chlorides are making their mark as dependable outdoor plastics when they include the remarkably effective protection offered by CYASORB Light Absorbers. These absorbers make PVC-fabricated products UV-stable—and also permit the manufacture of protective PVC films which are essentially UV-opaque.

CLEAR PVC Even clear sheets are given a new long-term practical service life by fractional percentages of CYASORB UV 9—and original clarity and color-free properties are unaffected. For thinner films, the higher ultraviolet absorption of CYASORB UV 24 is often recommended. In any case, surface protection combines with all-through protection to keep PVC sparkling clear.

PIGMENTED PVC Whites and pastels, in particular, keep bright and new-looking as CYASORB UV 9 or UV 24 shields against yellowing and greatly reduces surface deterioration.

RIGID OR FLEXIBLE PVC Formulation with CYASORB Light Absorbers presents no problem because of their excellent compatibility in resins and high solubility in plasticizers. CYASORB Light Absorbers are stable—are essentially inert in every respect other than their highly active ultraviolet absorption—and this is virtually undiminished even after years of severe exposure.

POLYESTERS, POLYSTYRENES, ACRYLATES, ACETATES and BUTYRATES . . . are among the many other resins finding new markets as CYASORB Light Absorbers offer economical assurance of greatly extended outdoor life.

CYANAMID

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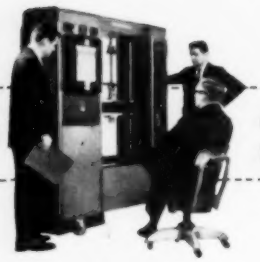

a new dimension in precision plastics testing

Viscoelastic Properties from Stress-Strain Data

Can viscoelastic properties of rubber-like materials be predicted from stress-strain data?

Here's how the problem was approached in a recent study. Stress-strain curves for polyisobutylene were developed on an Instron at several different strain rates and temperatures. Then, points on the curve were reduced mathematically to a single logarithmic stress-strain curve. Dynamic viscosity and stress relaxation modulus obtained from the data were compared with published experimental values.

The result? You can find it in Instron Bulletin PC-2, which describes this interesting study in full. It is one of many technical articles on advanced testing techniques from reliable, independent sources now available to you in reprint form. Just write

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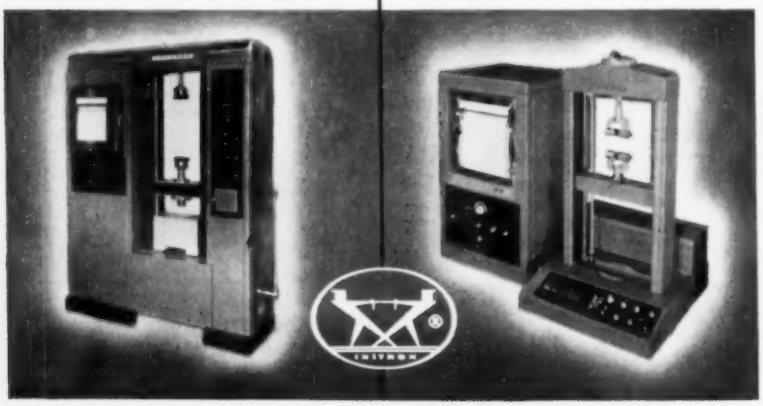
FLOOR MODEL INSTRON — *full scale load ranges: 2 grams to 10,000 pounds.*

TABLE MODEL INSTRON — *full scale load ranges: 2 grams to 200 pounds.*



in the rudder and center board. This type of construction reportedly offers stiffer, stronger boats which compete on a weight-stiffness basis with molded plywood hulls. The advantages of fibrous glass-reinforced polyester laminates are not sacrificed.

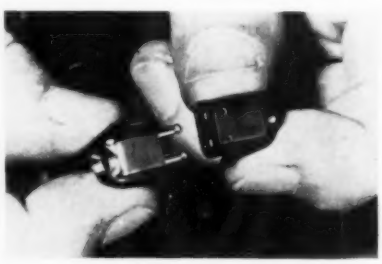
Readers' Service Item 45

Slide viewer is molded of impact styrene.

Impact-Styrene Slide Viewer

A plastic slide viewer of Bakelite TMD-5151 high-impact styrene has been made by J & M Zadiix Products Co. for Ciba Pharmaceutical Products, Inc., to illustrate the therapeutic value of a new preparation for the treatment of skin disease. Designed to show four slides before, during, and after treatment, it has been mailed as a kit to 80,000 physicians throughout the world by Ciba. Due to the material selection, the viewer is able to withstand the rigors of mail shipment and handling.

Readers' Service Item 46

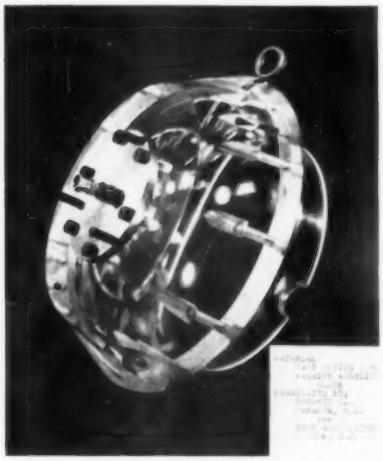


Miniature nylon connector assembly.

Miniature Nylon Connectors

Fluorocarbon Products, Inc., has introduced a miniature connector for Air Force pilot helmet earphones and other applications which weighs but 0.053-ounce. Made from Nylon FM 101, the Chemelec connector's male and female sections are 0.49- and 0.58-inch in length, respectively; 0.306- and 0.1453-inch deep. They feature snap-fit.

Readers' Service Item 47



Fabricated block of cast acrylic.

Massive Cast Acrylic Blocks

Cast acrylic blocks in a variety of sizes up to 24 inches thick are currently available from Cast Optics Corp. Called Evr-Kleer, the blocks can be machined to size as shown in the accompanying photograph. Here, Everett Co. has fabricated an acrylic head for Arde Associates, for observing the internal mechanism in testing equipment.

Readers' Service Item 48

Phenolic-Impregnated Bamboo

Golf putters featuring bamboo shafts impregnated with Bakelite phenolic resin are available from Charles F. Orvis Co., Inc. Four in number, the clubs have hexagonal shafts made from six triangular bamboo sections. These sections are impregnated with the phenolic and cemented together to form the waterproof, high-luster shaft. A variety of heads are offered along with tapered leather grips. Lengths are 34, 35, and 36 inches.

Bamboo putter is phenolic-impregnated.

Readers' Service Item 49

Polyethylene Housewares

Design in housewares is important, as borne out by the fact that the polyethylene items produced by Hutzler Mfg. Co. sell so well that their slightly higher cost is absorbed by the jobbers. Produced from Marlex, Phillips Chemical's high-density polyethylene, the trays and racks are highly decorative as well as functional.

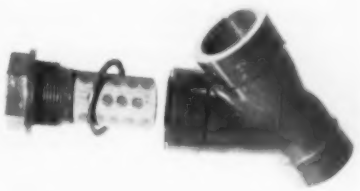
Polyethylene cutlery- and dishracks plus two bread trays.

Readers' Service Item 50

PVC Strainer Elements

A complete line of PVC strainers consisting of housing, strainer, and gasket has been introduced by Vanton Pump & Equipment Corp., a division of Cooper Alloy Corp. The firm manufactures plastic fluid-handling equipment.

The strainers are designed to trap particles which might be hazardous to the internal moving parts of process equipment. Light in weight, they can be installed directly with delicate equipment. Sizes range from ½-2 inches, with either socket ends for solvent weld connections, or with molded thread ends for greater accessibility.



All-PVC strainer elements.

Readers' Service Item 51

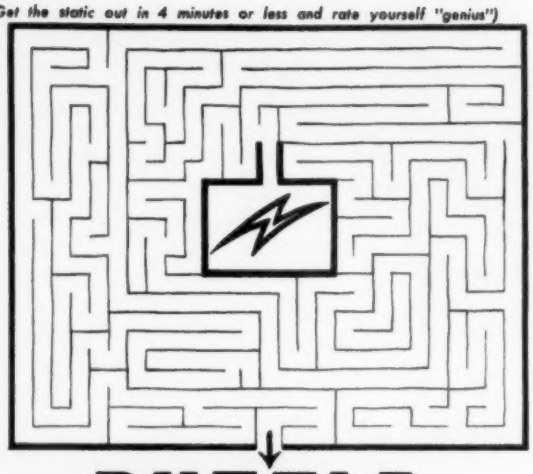
Butyrate Safety Glasses

Glendale Optical Co. has introduced a light-weight safety spectacle whose frame is made from cellulose acetate butyrate. Tradenamed Glentone, these glasses feature a universal bridge which will fit more than 90% of all users.

Designed to meet the needs of plant management, personnel, visitors, and others not directly engaged in activities not requiring heavier eye protection, Glentone spectacles are fitted with interchangeable lenses made of superhardened glass. Precision made barrel hinges eliminate temple rocking, and adjustable, wire-core spatula temples are provided in sizes from 5½-7 inches. The glasses are available in sizes 44, 46, and 48; and with clear, light, medium, or dark green lenses.

Readers' Service Item 52

(Get the static out in 4 minutes or less and rate yourself "genius")



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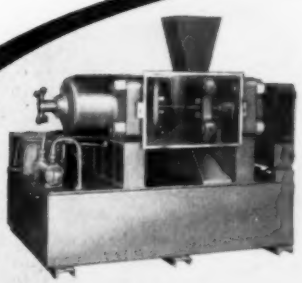

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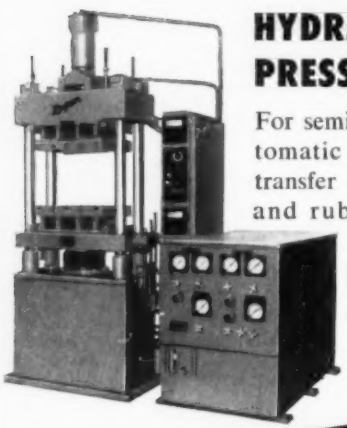

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New Literature

Write item numbers on Readers' Service Card (p. 95) to obtain more information.

"Sample Box of Formings." Falge Engineering Corp. This is not a bulletin but, as the title implies, a box containing samples of the various sized and shaped formings which the firm manufactures from Mylar, butyrate, acetate, and other sheet.

Readers' Service Item 61

"Application of the C. W. Brabender Plastograph to Resin-Plasticizer 'Mixability' Control." Application Bulletin No. 13. C. W. Brabender Instruments, Inc. 4 pages. Of special interest to dry-blenders of PVC resins, this bulletin explains how the Plastograph is used for the evaluation of "pasting" characteristics evidenced by various PVC and filler combinations in conjunction with plasticizers of various absorption values. Viscosities and duration of the "paste" stage, plus the point where the mixture reverts to free-flowing can be determined.

Readers' Service Item 62

"Rigithane 112 Urethane Foaming Resin for Use in Preparing Semi-Rigid and Rigid Foams." Thiokol Chemical Corp. 2 pages. Resin properties, directions for mixing, and suggested applications are given in this bulletin.

Readers' Service Item 63

"Mold Release Agents for Use with Rigithane 112." Thiokol Chemical Corp., 3 pages. Types and names of mold release agents which can be used with Rigithane 112 urethane foaming resin are listed in this bulletin. These include treated papers and films.

Readers' Service Item 64

"Comet Rotary-Vac Three-Stage Forming Machine." Comet Industries. 4 pages. This illustrated booklet shows how the unit does vacuum snap back, plug assist, blow-up vacuum reverse, reverse draw, male assist pressure forming, and billow forming.

Readers' Service Item 65

"Microwave Insulators." Bulletin 2895. Tri-Point Plastics, Inc. 2 pages. Microwave insulators of Teflon, Kel-F, styrenes, and other high-dielectrics, machined to tolerances of one mil and less are described in this bulletin.

Readers' Service Item 66

"Catalysts for Use with Rigithane 112." Thiokol Chemical Corp. 6 pages. The firm has developed a number of catalysts which can be used with this urethane foaming resin, characteristics and properties of which are listed. Compression/deflection. and tensile strength curves are depicted for resultant foams of varying densities.

Readers' Service Item 67

"Silicones." CDS-129A. General Electric Co., Silicone Products Department. 8 pages. G-E's major silicone products are described along with their uses.

Readers' Service Item 68

"Cadco Teflon." Cadillac Plastic & Chemical Co. 8 pages. This illustrated catalog lists available shapes and sizes, together with properties and end use applications.

Readers' Service Item 69

"Seven Plasticizers for Non-Toxic Applications." Monsanto Chemical Co., Organic Chemicals Division. 10 pages. Properties are given along with comparative performance data in terms of volatility, solvent and water resistance, low temperature flexibility, cost, and compatibility with various plastic materials.

Readers' Service Item 70

"Formulas and Tables for Polyethylene Film and Bags." U.S. Industrial Chemicals Co. 8 pages. The formulas and tables are intended to offer an accurate but easy method of computing polyethylene bag and film measurements, such as feet obtainable per pound of film; weight per 1,000 feet of film; weight per roll of film; average gage of film; weight per 1,000 bags; bags per pound of film; and average gage of bags.

Readers' Service Item 71

"Breaking Lubrication Barriers Through Research." Bulletin 121. Alpha-Molykote Corp. 4 pages. The bulletin is actually a selector chart for lubricants which will be used at different pressures. Other evaluations are based on temperature, environment, method of application, incorporation into common materials, and recommendations.

Readers' Service Item 72

"How To Buy Custom Molded Plastics." Monsanto Chemical Co., Plastics Division. 6 pages. This bulletin is actually a 14-question check list for manufacturers thinking of buying plastic components or parts. Emphasis is on product improvement and lowered costs.

Readers' Service Item 73

"Hannifin Valve Finder." Bulletin 234. Hannifin Co. 12 pages. This bulletin is simultaneously a catalog and a source reference for information on directional air control valves. Included is a three-step outline covering valve types, means of actuating, and operating principles.

Readers' Service Item 74

"IMS Silicone Spray and Other Mold Releases." Injection Molders Supply Co. 16 pages. Uses and advantages are listed for the material, as well as prices. Also listed are IMS' cheaper No Label Silicone, Paintable Silicone, Netural Oil Spray, and Zinc Stearate Dry Spray.

Readers' Service Item 75

"Genwall Random Plank." General American Transportation Corp. 6 pages. Directions for installation are given along with specs. Though the booklet does not state it definitely, Genwall is apparently Mylar printed on the underside with a wood-grain finish plus a ¼-inch substrate.

Readers' Service Item 76

Changing the density?

Changing the resin?

Changing the product?...

NO PROBLEM

with HARTIG equipment

Hartig 3½" Extruder
L/D Ratio, 21:1
Effective Screw Length: 73½"
Nominal Capacity: 200-250 lbs./hr.
Barrel Heat: 13 bands, 2500 W ea.
Control Zones: barrel 3, die 1
Temperature Controls: 4 (proportioning)
Thrust Bearing Capacity: 221,900 lbs.
Floor Dimensions: 111" x 70" (belt drive)
Weight (approx.): 5000 lbs.
Motor Drive (belt): 25-40 hp.

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Book Reviews

"Polymerization Studies on Monomers and Evaluation of Derivative Polymers: Part II." F. B. Jones, R. A. Markle, P. B. Stickney, and R. G. Heiligmann. Battelle Memorial Institute for Wright Air Development Center, U.S. Air Force. Order PB 131778 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 101 pages. Price, $2.75.

This report describes the research which was undertaken to determine polymerization characteristics of a group of experimental monomeric compounds. It includes also a preliminary evaluation of the resulting polymeric products' potentials as thermally stable, solvent-resistant materials.

Work with addition polymers included: polymerization of some fluorine-containing olefine oxides; copolymerization of perfluoropropylpropenyl ketone with a series of butadienes, perfluoromethylpropenyl ketone with butadiene, and perfluoroheptylpropenyl ketone. Evaluations were made of experimental addition materials including: homopolymers of the fluorine-containing olefine oxides; copolymers of perfluoroalkylpropenyl ketone/1,3-diene; and perfluoro-1,4-pentadiene copolymers. Evaluations of a number of condensation products also are given.

"Branching Reactions in the Polymerization of Vinyl Acetate." M. Morton and I. Piirma, University of Akron for Wright Air Development Center, U.S. Air Force. Order PB 151245 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 30 pages. Price, $1.00.

Transfer constants of polymethyl methacrylate and polyvinyl acetate were studied in their respective homopolymerizations, as well as in graft copolymerizations. The monomers were polymerized in the presence of varying amounts of oligomers, followed by careful separation of the resulting polymers. The effect of oligomer end-groups was determined by using oligomers of different molecular weight. Since methyl methacrylate polymerizations were extremely difficult due to the complicated kinetics introduced by the Trommsdorff effect, the investigation was limited to vinyl acetate polymerization. For a vinyl acetate radical with a polystyrene chain, the transfer constant was found to be 1.6×10^{-3} at 60° C. This was much higher than the value found for the transfer constant of 2.2×10^{-4} for methyl methacrylate radicals with polystyrene.

"Organic Polymers Containing Aluminum and Titanium." R. L. Frank, A. A. Baldoni, and T. R. Patterson, Jr., Morton Chemical Co. for Air Force Office of Scientific Research. Order PB 131753 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 12 pages. Price, $.50.

Formation and properties of two types of chelated aluminum polymers were studied. Monochelated polymers prepared from diisopropoxy or dichloro aluminum monochelates had limited hydrolytic and thermal stability. Polymers of trichelated aluminum were more resistant to hydrolysis. These polymers vary from low-melting, readily organic-soluble thermoplastics to intractable solids stable at 360° C. Linear polymers were prepared from dichelated titanium diisopropoxides and organic diols. The most stable of these was the product from an 8-quinolinol chelate and 2,2-bis (4-hydroxyphenyl) propane.

"Degradation Studies on Condensation Polymers." M. A. Deisz and M. Ohta, University of Akron for Signal Corps, U.S. Army. Order PB 131795 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 86 pages. Price $2.25.

Degradation studies on condensation polymers such as the polysiloxanes and polyurethane polyesters are reported. The investigation, which took place over a two year period, sought information on the nature of the breakdown of polycondensate linkages in these polymers. Reactions of 1-butanol with two of the more commonly used diisocyanates, TDI and MDI, in xylene were studied. These reactions were found to follow over-all second-order kinetics to at least 60% completion. One isocyanate group in the TDI molecule was approximately 10 times more reactive than the other, but in the MDI isocyanate groups the reactivity was about the same.

Second-order constants for the reactions of phenyl isocyanate with alcohol, water, acid, urethane, substituted urea, and substituted amide were established. A study also was conducted on the rate of degradation of an unfractionated polydimethylsiloxane in tetrahydrofuran solutions containing aqueous hydrochloric acid. This rate was shown to follow over-all first-order kinetics as measured by the change in number-average molecular weight of the polymer.

"59-11239 Organic Silicon Compounds." K. A. Andrianov. State Scientific Technical Publishing House for Chemical Literature, Moscow, 1955. Order from OTS, U.S. Department of Commerce, Washington 25, D.C. 920 pages. Price, $10.00.

Translated from the Russian by the U.S. Air Force and published by the Office of Technical Services, this monograph was prepared from technical literature and from the author's own experience in the practical development of this relatively new material.

Methods of preparation as well as the physical and chemical properties of large numbers of both monomeric and high-polymer organosilicon compounds are included. The book also covers uses of these compounds in such fields as electrical materials, metals coatings, lubricants and hydraulic fluids, plastics, precision castings, and textiles.

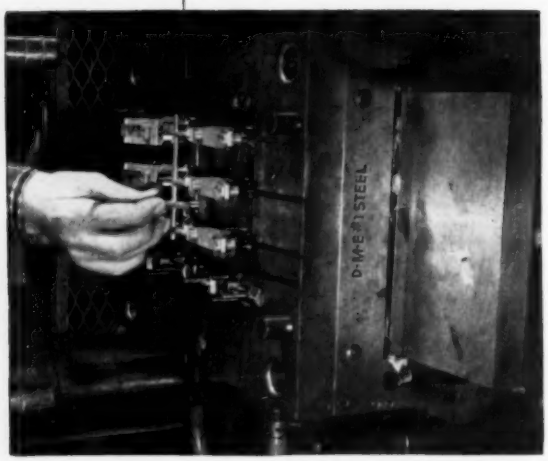
"Biocides For a Strippable Vinyl Plastic Barrier Material." S. H. Ross, Ordnance Corps, U.S. Army. Order PB 151119 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 25 pages. Price $.75.

Two biocides were found effective in preventing property changes in a strippable vinyl plastic barrier material (Specification MIL-P-12121C) after microbial attack. Incorporated into the films, the biocides copper-8-quinolinate and 1-hydroxy-2(1H)-pyrodinethione zinc salt prevented fungus growth and consequent loss of plasticizer and flexibility. Results of an evaluation of a number of commercial and experimental biocides are reported.

"Vinyl-Lacquer Coating For Interior of Military Steel Pipeline Tubing." S. J. Holzsweig, U.S. Army Engineer Research and Development Laboratories. Order PB 151013 from OTS, U.S. Department of Commerce, Washington 25, D.C. Paper, 42 pages. Price, $1.00.

Vinyl-lacquer coatings were found to be effective in protecting the interior of steel tubing against atmospheric corrosion during storage. The coating also eliminated the need for cleaning pipelines with a brush-type cleaner. The tests involved exposure of the coated tubing, of the type used for handling petroleum products, to gasoline, jet fuel, and water. It was also found that a coated pipeline will not have a lower line-pressure loss than a clean bare-steel pipeline. The coated pipeline was shown to accelerate formation of gum in fuels at a much higher rate than an uncoated steel pipeline.

6,000 COMBINATIONS



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News of Industry *(Cont'd. from page 64)*

new plants and laboratories

General Electric Co. has acquired land and drawn up plans for a plant to produce Lexan polycarbonate resin commercially. A 180-acre site on the Ohio River two miles southwest of Mount Vernon, Ind., was chosen, and the plant should be in operation by the latter part of 1960. Provisions for future expansions have been included.

Tube-Kote, Inc., has initiated pipe-coating production at its new plant near Midland, Tex. Built on a 17-acre plot, the $250,000 facility has a capacity for coating 8,000 feet of pipe per day, and will employ 30-35.

Hooker Chemical Corp. dedicated its research center at Grand Island, N. Y., on June 2. The $3.5-million center includes all the latest in industrial laboratory research design.

Reichhold Chemicals, Inc., placed the first phase of its new resin plant on stream last month. Located on the Greens Bayou Branch waterway, the $1-million unit is RCI's 17th domestic plant. Facilities were designed to accommodate considerable future expansion in alkyd and polyester capacity, and the firm envisions eventual production of other synthetic resins and basic chemicals.

Appleton Machine Co. has established a research laboratory to test paper, textiles, synthetic fabrics, plastics, and leathers, as well as develop improved methods of slitting and winding. The company's new services are offered without charge, and laboratory facilities are vailable to any firm sending a sample of its material and specifications for slitting and winding.

Textileather division, General Tire & Rubber Co., plans to erect a plant which will house a giant, high-speed calender. Completion of the $1-million program is scheduled for the fall. The division will then be able to produce finished vinyl in widths to 84 inches. Over 10,000 square feet of working space will be available.

government awards

Trimount Plastic Co., Inc., Arlington, Mass., has been awarded a contract for supplying 24,250 transparent plastic sheets. Width is 20 inches by 50 inches long and 30 mils thick.

House Glass Corp., Point Marion, Pa., was awarded a contract by the Navy Department's Bureau of Ordnance for research and development of fiberglass-reinforced plastics to be used in propulsion systems. NOrd-18701.

Abstracts of Important Articles

Materials

"Low Temperature Cracking Test for Plasticized PVC," D. Wormald, *Brit. Plastics*, 31, 9, 392 (Sept. 1958).

Equipment and a method were developed for carrying out low-temperature flex cracking tests on unsupported PVC sheet, as used for handbags. The flexing machine is actuated by solenoids to give a rapid folding action, and service conditions involving intermittent flexing and relatively long periods with the sheet remaining folded were reproduced. Testing was carried out at 5° C. The influence of plasticizer, filler, pigment, and embossing were investigated. In some cases, embossing was found to reduce flex life by one-half or more, and this effect is being studied further.

"Polyvinyl Alcohol," R. E. Grandpre, *Plastics World*, 17, 3, 16 (March 1959).

A brief review of the properties, additives, and uses for the material.

"Visual Standards for Reinforced Plastics," W. E. Smith and W. A. Severance, *Materials Design Eng.*, 49, 3, 106 (March 1959).

Photos and descriptions of what to look for when checking parts against material specifications.

"Correlation of Peroxide Half-Life with Polymerization," O. L. Mageli, S. D. Stengel and D. F. Doehnert, *Modern Plastics*, 36, 7, 135 (March 1959).

Results of tests show the importance of half-life data as the first step in selecting an organic peroxide initiator.

"Pitfalls in Evaluation of PVC Plasticizers," C. H. Fuchsman, *SPE J.*, 15, 3, 214 (March 1959).

Some rules for testing vinyl stabilizers are presented.

"How to Measure Uniformity and Predict Molding Characteristics of Polyester Premixes," A. F. Torres and S. S. Feuer, *Modern Plastics*, 36, 8, 124 (April 1959).

Reactivity and extrusion tests offer a basis for measuring the effects of experimental changes in molding compound compositions.

"Plastics Films for a Growing Market," B. M. Miller, *Plastics World*, 17, 4, 22 (April 1959).

Comparison of films made from medium- and high-density polyethylene, polypropylene, and nylon 6.

"Progress in Urethanes," M. E. Bailey, *SPE J.*, 15, 4, 285 (April 1959).

A generalized review of flexible foams, rigid foams, urethane coatings, adhesives, and solid elastomers.

"Diepoxides With Improved Properties," D. R. Beasley, *SPE J.*, 15, 4, 289 (April 1959).

A description of three new diepoxides that expand the range of epoxy applications.

"Castable Conductive Plastics," W. C. Tanner, *SPE J.*, 15, 3, 216 (March 1959).

Commercial polyester resins filled with graphite and ammonium perchlorate are shown to produce acceptable products.

"Nuclear Resonance Studies of Polymer Chain Flexibility," W. P. Slichter, *SPE J.*, 15, 4, 303 (April 1959).

A discussion of how intermolecular forces and molecular shape affect flexibility.

"A New Family of Dielectric Materials," C. L. Petze, Jr., *Western Plastics*, 6, 3, 38 (March 1959).

Description of new materials developed from organosiloxanes.

"Mixed Polyamides Containing Piperazine," C. W. Hamilton and M. M. Epstein, *Modern Plastics*, 36, 8, 150 (April 1959).

Results of tests are given on copolymer and terpolymer systems.

Equipment

"A New Safety Guard for Two-Roll Mills," D. J. Mills and G. W. Tice, *Brit. Plastics*, 31, 7, 308 (July 1958).

The Mills-Tice Guard described completely encloses the mill, and is made possible by the introduction of an air-operated knife for automatic cutting. Method of operation and advantages are detailed.

"Autogenous and Conventional Single-Screw Extruders for Processing Plastics. A Critical Review of the Present Situation," G. Schenkel, *Kunststoffe*, 48, 11, 505 Nov. 1958).

The author compares autogenous or adiabatic heating and polytropic heating (the latter involving both external heating and cooling and conversion of energy to heat) of single-screw extruders, first reviewing the present situation of these techniques, the special features of different types of machines and underlying thermodynamic principles. He examines the claims of advocates of autogenous heating, and shows that elimination of external heating and cooling elements results in a limitation of the range of application of the machines which can only be compensated by changing pressures or basic design. The theory basic to his views is analyzed, and he gives working diagrams for adiabatic and conventional processing of polyethylene showing the relation of out-put to pressure and temperature, as well as relevant equations from which model laws could be derived to aid in designing and operating plastics extruders. The relation of temperature rise to the number of screw revolutions will be studied in a future article. (In German.)

"Measuring Melting Point or Flow Temperature with an Automatic Melting Point Recorder," K. Ueberreiter and H.-J. Orthmann, *Kunststoffe*, 48, 11, 525 (Nov. 1958).

In this method, the material is heated between two cover glasses under slight pressure, instead of in a capillary tube. The apparatus consists of a stove with heat regulator and light-measuring and recording devices. Fully automatic and easy to manipulate, it is designed for determining melting point of crystalline micro- and macro-molecular materials, as well as for rapid indication of flow properties of glassy polymers. Analysis of results of flow-temperature measurements on different materials indicate the existence of an iso-viscous state that is of practical importance. It also is shown that the flow-temperature measurements can be used to estimate molecular weight of polymers correct to 3% if curves of standard samples of known molecular weights are available. (In German.)

Processing

"Pinpoint Important Process Variables with Polyvariable Experimentation," F. E. Satterthwaite and D. Shainin, *SPE J.*, 15, 3, 225 (March 1959).

A simple, non-mathematical statistical system for trouble-shooting is given.

"Vinyl Plastigels," W. A. Riese, *Kunststoffe*, 48, 9, 436 (Sept. 1958).

The methods and materials used in producing vinyl plastigels from the plastisols and how they are processed are described. Formulas are given for preparing plastigels suitable for chemically-resistant container linings, and for use as a modeling material. (In German.)

"Vacuum-Forming of High Molecular Polyamides," W. Stiner, *Kunststoff-Rundschau*, 5, 1, 1 (Jan. 1958).

New types of Nylon 6, marketed as Grilon R 50 and Grilon R 70, with molecular weight of 70,000 and 85,000, respectively, and melt viscosities at 250° C. of 500,000 and 1,000,000 respectively, can be vacuum-formed if the proper precautions are taken. Preliminary tests are described and some of the problems encountered are discussed. (In German.)

"Factors Influencing the Mechanical Properties of Hand-Welded Rigid PVC," A. Herrmann, *Plaste u. Kautschuk*, 5, 1, 13 (Jan. 1958).

The effect on the mechanical properties of hot-air, hand-welded PVC was studied, including the temperature of the air; distance between nozzle and weld; pressure on the bead; angle at which the bead is applied; nature of welding edge; and optimum conditions. (In German.)

"Factors Affecting the Formability of Extruded Sheet Plastics" E. L. Williams and T. R. Twitchett, *Rubber & Plastics Age*, 39, 7, 575 (July 1958).

Two classes of factors affect the formability of extruded sheet plastics: those relating to machine operation; and those depending on the sheet. This is illustrated by examples of the production of a polystyrene refrigerator liner, and of a preprinted display item.

"The Fabrication of Blown Hollow Articles from Rilsan," J. Peyinchou, Ind. *Plastiques Mod.*, 10, 9, 28 (Nov. 1958).

Current blow-molding methods can be used in making hollow articles from Rilsan (the French Nylon). Factors likely to influence results and precautions to be taken are discussed, as are type, compression ratio, and plasticizing capacity of the extruder screw; type of extruder head; extruder feed; pre-treatment of the material; working temperatures; and types of injection machines and molds. (In French.)

"Bonding Rigid PVC Sheet to Chipboard and Fiber Board," C. Kubitzky, *Kunststoffe*, 48, 11, 549 (Nov. 1958).

The preparation of chipboard and fiberboard destined to be surfaced with rigid PVC and used for furniture is described, as well as the adhesives recommended and the methods of assembling. For testing, specifications of the U. S. Forest Products laboratories have been selected. (In German.)

"Faster Cure Through Hotter Electronic Preheat," A. J. Guzzetti and R. L. Wechsler, *SPE J.*, 15, 4, 293 (April 1959).

How electronic preheating permits faster molding operations.

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. The publishers and their addresses are given below:

"Applied Plastics"
The Scientific Press, Ltd.
11 Gloucester Road
London, S.W. 7, England

"ASTM Bulletin"
American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

"Australian Plastics"
Australian Trade Publications, Ltd.
171 Sussex St., Sydney, Australia

"British Plastics"
Iliffe & Sons, Ltd.
Dorset House, Stanford St.
London S.E.I., England

"Canadian Plastics"
341 Church St., Toronto, Ont., Canada

"Chemical and Engineering News"
1155 Sixteenth St. N.W.
Washington 6, D.C.

"Hule Mexicano y Plasticos"
Filomeno Mata 13-11, Mexico, D.F.

"Industrial and Engineering Chemistry"
1155 Sixteenth St. N.W.
Washington 6, D.C.

"Industries des Plastiques Modernes"
Les Publications Techniques Associees
40 Rue du Colisee, Paris 8e, France

"Kunststoffe"
Carl Hanser Verlag
Leonard Eck Str. 7, Munich 27,
Germany

"Kunststoff-Rundschau"
Brunke Garrels, Verlagsbuchhandlung
Borgfelder Strasse 83, Hamburg 26,
Germany

"Materials and Design Engineering"
Reinhold Publishing Corp.
430 Park Ave., New York 22, N. Y.

"Materie Plastiche"
Via Farneti 8, Milan, Italy

"Matiéres Plastiques"
Galerie du Center, Bloc 3
Rue des Fripiers, Brussels, Belgium

"Mechanical Engineering"
American Society of Mechanical Engineers
29 W. 39th St., New York 18, N.Y.

"Modern Plastics"
575 Madison Ave., New York 22, N.Y.

"Oesterreichische Plastic-Rundschau"
Ployer & Co.
Aegidiengasse 5, Vienna 6, Austria

"Plaste und Kautschuk"
Veb Verlag Technik
12 Unter den Linden
Berlin N.W. 7, Germany

"Plastic"
Danish Technical Press
31 Vester Farimogsgade
Copenhagen 5, Denmark

"Plastica"
Kunststoffeninstituut T.N.O.
Julianalaan 134, Delft, The Netherlands

"Plastics"
Temple Press, Ltd.
Bowling Green Lane, London E.C.I.
England

"Plastics World"
Cleworth Publishing Co., Inc.
1 River Road, Cos Cob, Conn.

"Plastiques Informations"
94 Rue Saint-Lazare
Paris 9e, France

"Plastverarbeiter"
Verlagsgec. m.b.H.
Herxheim b. Landau/Pfalz, Germany

"Poliplasti"
E.T.A.S., Via Andrea Mantegna 6,
Milan, Italy

"Revista de Plasticos"
Inst. "Alonso Barba"
Serrano 119, Madrid, Spain

"Revue Générale des Matiéres Plastiques"
196 Ave. Jean-Jaures, Paris 19e, France

"Rubber and Plastics Age"
Rubber and Technical Press, Ltd.
Tenterden, Kent, England

"SPE Journal"
65 Prospect St., Stamford, Conn.

"Transactions of the Plastics Institute"
6 Mandeville Place, London W. I.
England

Western Plastics
Western Business Publications
274 Brannan Street
San Francisco 7, Calif.

Applications

"Some Problems in the Use of Glass-Reinforced Laminates in the Chemical Industry," F. F. Jaray, *Brit. Plastics*, 31, 8, 342 (Aug. 1958).

The factors influencing the strength of glass fibers, the limitations of the linking agent (or glass "finish"), and reasons for the failure of glass resin laminates chiefly are dealt with. Means of overcoming technological deficiencies in the wet lay-up method are discussed. Reference is made to investigations in Europe and America on new glass modifications, treatments to increase efficiency of the linking agent, the effect of covering the fiber with a thin elastomeric layer, the use of linking agents with amino group bonds, the advantage of using soft resins, and improvements obtained for specific purposes by pre-stressing laminates or by the use of uni-directional cloth or mat.

"Polyvinyl Adhesives," C. Martin Ampudia, Rev. de Plasticos, 9, 50, 90 (Mar.-April 1958).

The chemistry of the production of polyvinyl acetate and polyvinyl alcohol, the different forms in which polyvinyl adhesives are applied, and their action are dealt with. (In Spanish.)

"Experiments in Protecting Boat Hulls with Polyethylene," T. Engel, *Kunststoffe*, 48, 10, 494 (Oct. 1958).

Sheets of polyethylene were used successfully in experiments aimed at the protection of wood ship hulls from marine organisms. The sheets were nailed in place with copper nails, and then welded. Marine algae deposited during two months in port adhered only lightly, and were practically all removed by friction of the water after 42 hours of sailing. Treatment of the polyethylene with a poison led to a considerable decrease in algae deposits; teredo apparently did not even attack the untreated plastic. The protection of steel hulls is more difficult, and experiments are still in progress. (In German.)

"Plastics for Medium and Large Capacity Containers," E. H. Doerpinghaus, *Kunststoff-Rundschau* 5, 1, 5; 5, 2, 43 (Jan. & Feb. 1958).

Rigid and flexible plastic containers for storage and transportation of gas and fluids are considered, including fresh water tanks for ships; swimming pools; floating containers for oil; and rigid containers lined with plastics or having a separate flexible liner for underground or overhead storage of gas, as well as for storing or transporting fluids. Reference is made mainly to American practice, and it is noted that German plastics manufacturers, as compared with their American opposites, are very sparing of the information they give on chemical resistance, application and processing of their products. (In German.)

"Synthetic Resins in Light Weight Structures," H. Rebeski, *Kunststoffe*, 48, 10, 450 (Oct. 1958).

The construction of a passenger plane is described as an example of a light-weight structure bonded with synthetic resin. Requirements as to suitability of the adhesives and processing conditions are discussed. The adhesive used was an English two-component system consisting of phenol formaldehyde as wetting agent, and a polyvinyl acetal film to take up the shearing stresses. (In German.)

"Plastics in the Electronics Industry," R. L. Mondano and A. I. Simon, *Plastics World*, 17, 1, 6 (Jan. 1959).

Some advances in "alloying" and reinforcing plastics materials to obtain properties needed for specific applications are described.

"Where to Use Urethane Foams," T. P. Dougan, *Materials Design Eng.*, 49, 1, 86 (Jan. 1959).

A brief description of where rigid, semi-rigid, and flexible urethane foams can be used.

"Plastics' Prospects in Building," G. R. Hermach, *Western Plastics*, 5, 12, 23 (Dec. 1958).

Brief outline of potential uses for plastics in the building industry.

"Reinforced Plastics in Chemical Engineering," W. A. Szymanski, *Plastics World*, 17, 2, 10 (Feb. 1959).

A review of uses and advantages of plastics, especially polyester- base laminates.

"Engineering Molded Parts for Business Machines," B. W. Nelson, *SPE J.*, 15, 2, 131 (Feb. 1959).

How a captive molding plant achieves accuracy and dependability of molded parts.

"Production, Testing and Properties of Decorative Melamine Laminates," H.-J. Konig, *Kunststoffe*, 48, 11, 513 (Nov. 1958).

A discussion of the use of melamine-formaldehyde, paper-reinforced laminates for decorative and sanitary purposes. After reviewing available materials in Germany and the properties required of the resins and papers, the author describes in detail the various processes and equipment employed, as well as the most important tests (chiefly N.E.M.A. methods). (In German.)

"What's in Store," C. Craig, *Brit. Plastics*, 31, 9, 366 (Sept. 1958).

A British housewife studies the use of plastics for the nursery and reports some unexpected verdicts of private consumers, nursery schools and toy experts on certain popular items.

General

"Plastics in Czechoslovakia," G. Prochazka, *Brit. Plastics*, 31, 9, 382 (Sept. 1958).

Czechoslovakia's plastics industry is based mainly on materials produced from coal-derived chemicals and, to a lesser degree, on agricultural and mineral derivatives. Methods followed producing plastics, the solvents, fillers, and other ingredients available, and uses for various resins are described.

"What's New in Plastics," M. W. Riley, *Materials Design Eng.*, 49, 4, 105 (April 1959).

Highlights of papers presented at the SPE ANTEC last January.

"The Electron Microscope in the Study of Plastics Materials," E. Dalle Nogare, *Materie Plastiche*, 24, 1, 39 (Jan. 1958).

The use of the electron microscope to study macromolecules started in 1938. How it has served in determining molecular weight, and in the study of dispersions, polymerization processes, spherulite structures, etc., is reviewed. There are 69 references. (In Italian.)

"Plastics and Plastics Equipment at the Achema 1958," J. Hausen, *Kunststoffe*, 48, 9, 409 (Sept. 1958).

The author describes a number of exhibits of interest to the plastics industry seen at the Achema Exhibition 1958, including plastics materials, manufacture (especially of the fluorine plastics) for chemical and technical purposes as chemically-resistant linings, apparatus and components wholly or partly of plastics; auxiliary equipment for plastics processing; and testing devices. (In German.)

Patent Digest

Materials

Polymerization of N-Vinyllactam. No. 2,856,338. Frederick Grosser, North Plainfield, N.J. (to General Aniline & Film Corp., New York, N.Y.).

An aqueous solution of N-vinyl-lactam, containing a small amount of peroxide catalyst and an ammonium hydroxide activator, is exposed to ultra-violet light to produce a high polymer having a K value of 50-100. The reaction is carried out without rigid exclusion of oxygen or redistillation of the monomer.

Vinyl Resin Impregnated Rayon Cordage. No. 2,856,750. Ellis Lewis, Jenkintown, Pa. (to American Viscose Corp., Philadelphia, Pa.).

Vinyl resin is distributed within cordage consisting of regenerated cellulose filaments. The cordage has a twist of 0.8-1.5 turns per inch, and the resin is a dried product consisting of the resin and an organic solvent.

Polyethylene-Estersil Composition. No. 2,857,355. Ralph K. Iler, Brandywine Hundred, Del. (to E. I. du Pont de Nemours and Co.).

The composition consists of an organophilic estersil which has been wetted in a butanol-water mixture and dispersed in polyethylene. The estersil comprises a supercolloidal substrate coated with —OR groups which are chemically bound to a silica surface. R is a hydrocarbon radical having from 2-18 carbon atoms where the carbon atom attached to oxygen is also attached to hydrogen.

Epoxy Resin. No. 2,857,362. Ridgley G. Shepherd, Jr., Weston, and Elizabeth C. Dearborn, Boston, Mass. (to U.S. Testing Co., Inc., Hoboken N.J.)

A cross-linking agent consisting of carboxylic acid anhydrides and amines is compounded with 2,2,4,4-tatrakis (4-glycidyloxyphenyl) pentane and 2,2,5,5-tetrakis (4-glycidyloxyphenyl) hexane.

Stable Aqueous Dispersions of Copolymers of Vinyl Acetate With Salts of Allylsulfonic Acid and Methallylsulfonic Acid and Process for Preparing Same. No. 2,859,191. Norris Turnbull, Grand Island, N.Y. (to E. I. du Pont de Nemours and Co., Wilmington, Del.)

Vinyl acetate and a small amount of an alkali metal salt of allylsulfonic acid and methallylsulfonic acid are polymerized in an aqueous medium in the presence of a catalyst. The reaction is carried out at a temperature between 60-90° C.

Polymerization of Caprolactam With An Alkali Metal Alkoxide Catalyst in an Excess of Alcohol. No. 2,857,364. George H. Berthold, Guilford, and Richard N. Lewis, North Haven, Conn. to Olin Mathieson Chemical Corp., New York, N.Y.).

Caprolactam is polymerized by heating it to 225-260° C. in the presence of 0.35-1.5 mole percent of an alkali metal alkoxide of an alcohol containing from 4-6 carbon atoms. The alkoxide is dissolved in 3-5 times its weight of the alcohol.

Manufacture of Low Molecular Weight Olefin/Maleic Anhydride Copolymers. No. 2,857,365. John H. Johnson, Dayton, O. (to Monsanto Chemical Co., St. Louis, Mo.).

Maleic anhydride is copolymerized with an olefin having from 2-4 carbon atoms in the presence of a compound selected from the group consisting of R-dihydrogen phosphites and di-R-hydrogen phosphites. R is a monovalent hydrocarbon radical.

Monofluoroacetylene, Polymers, and Preparation. No. 2,857,366. William J. Middleton, Claymont, Del. (to E. I. du Pont de Nemours and Co., Wilmington, Del.).

Solid, thermoplastic monofluoroacetylene polymer.

Process for the Polymerization of Resins for Use in Taste-Like Dispersions. No. 2,857,368. Robert B. Ingraham, Midland, and Glen L. Gunderman, Clare, Mich. (to Dow Chemical Co., Midland, Mich.).

Prior to polymerization, from 0.002-0.05% by weight of a high molecular weight polymer of acrylamide is added to an aqueous vinyl chloride dispersion which contains a water-soluble catalyst.

Polymerization Process Utilizing Dextran as a Primary Dispersing Agent. No. 2,857,367. James J. Kearney, Fairport Harbor, O. (to Diamond Alkali Co., Cleveland, O.).

A polymerizable monoethylenic monomer is dispersed in water with the aid of a small quantity of dextran and polymerization is effected to produce a high-quality polymeric material.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each.
—The Editor

Equipment

Apparatus for Drawing of Synthetic Fibres. No. 2,853,738. Josef Pfenningsberg and Hans Richter, Munich-Gladbach, Germany. (to Josef Pfenningsberg & Co., Munich-Gladbach, Germany).

This apparatus is designed for hot or cold drawing of thermoplastic high polymer threads. It consists of a feeding roller and a drawing roller, each of which is equipped with a deflecting roll. Each set is mounted on a swing lever, and the driving means engages the feeding and drawing rolls. The swing levers are pivotally mounted to a vertical shaft so that either can swing around its axis and disconnect its associated roller from the driving unit.

Method and Apparatus for Making Plastic Articles. No. 2,858,564. Orville B. Sherman and Leonard D. Soubier, Toledo, O. (to Owens-Illinois Glass Co., Toledo, O.).

An extrusion nozzle is adapted to extrude plastic material vertically downward in tubular form. An annular series of forming molds are mounted on a horizontal table which rotates intermittently to move them in a closed path.

Method and Apparatus for the Centrifugal Casting of Fiber-Reinforced Plastic Pipe. No. 2,859,151. Ernest M. Usab and Martin A. Usab, Gardena, Calif. (to Reflin Co., Gardena, Calif.).

The apparatus consists of an elongated casting cylinder; means for mounting the cylinder for high speed rotation around its longitudinal axis; a slotted mandrel about which fabric is wrapped; means for introducing a thermosetting liquid resin into the interior of the cylinder for distribution on the fabric; and means to heat the cylinder, while it is being rotated, to set the resin.

Processing

Process For the Production of Polyethylene-Wax Blends. No. 2,857,352. Lewis D. Etherington, Cranford, Raymond G. Newberg, Roselle Park, Howard Wilson, Middlesex County, and Andrew F. Sayko, Westfield, N.J. (to Esso Research and Engineering Co., New York, N.Y.).

Ethylene is polymerized in the presence of a reaction medium consisting essentially of benzene. When the reaction is nearly complete, molten petroleum wax is added and the benzene is removed. The polymerization is effected at a temperature from 70-225° C., and a pressure between 1,500-30,000 psig.; while the substitution is performed between 60-150° C.

Method of Making Metal Reinforced Plastic Bodies. No. 2,852,840. Kelsey I. Harvey, Beaver, Pa.

A tape containing an unpolymerized plastic is wrapped about a metal tubular core. The combination is heated to initiate polymerization and simultaneously squashed to form a solid, integrated mass. This is reformed in the shape of the desired structural member, and heated further to polymerize the plastic completely. The resulting solid structure is cut into lengths.

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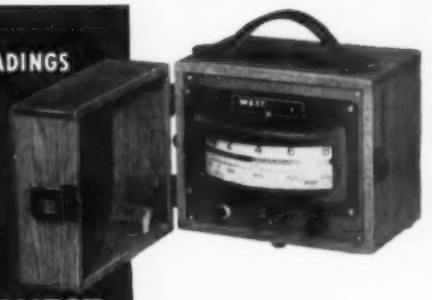

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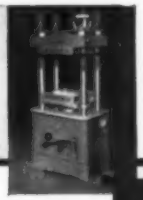

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Method for Casting Thin Plastic Films. No. 2,852,811. John V. Petriello Queens Village, N.Y.

A thin plastic film is both continuously cast and stripped from a non-oxidizable metal carrier which is continuously polished to maintain a surface roughness less than 250 micro-inches.

Method of Preparing Wire Insulated With a Vinyl Resin. No. 2,855,631. Arthur C. Rowley, Stratford, Conn. (to General Electric Co., New York, N.Y.).

A plastisol is prepared and fed into an extruder where it is heated to its fusion temperature. The fused plastisol then, is extruded onto a conductor.

Method of Manufacturing Plastic Sheet Material With Pearl Essence Incorporated Therein. No. 2,856,635. Edward Gerson, Great Neck, and Paul Bruins, Douglaston, N.Y. (to Patrician Plastic Corp., Paterson, N.J.).

Polymeric, unsaturated polyester resin, pearl essence, a catalyst and promoter, are centrifugally cast into tube form. The casting operation is terminated and, while the tube is in a flaccid condition, it is made into sheet form from which article blanks are stamped. This latter operation is performed before chemical cross-linking of the resin is completed.

Process of Making Glycidyl Methacrylate Polymer Composition Containing Same, and Product Coated Therewith. No. 2,857,354. James C. Fang, Sharon Hill, Pa. (to E. I. du Pont de Nemours and Co., Wilmington, Del.)

This liquid coating composition is made up of: a copolymer of glycidyl and an ethylenically unsaturated compound consisting of styrene, methyl methacrylate, and butyl methacrylate; a saturated straight chain aliphatic dicarboxylic acid containing 5-20 carbon atoms per molecule and in the amount of 0.3-1.0 mol per mol of glycidyl methacrylate; and a volatile organic solvent for the copolymer and the acid.

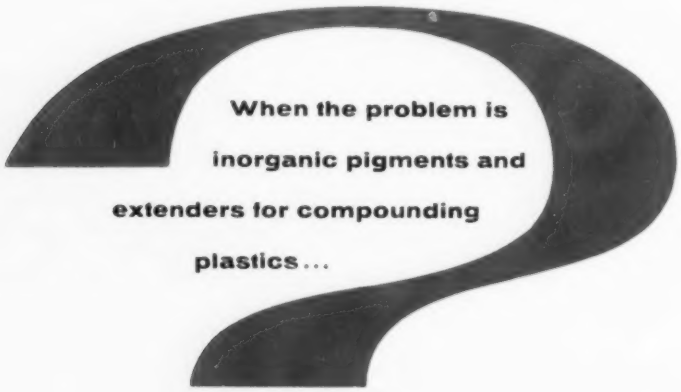
Catalytic Production of Polyethylene Terephthalate. No. 2,857,363. William K. Easley, Julian K. Lawson, and James B. Ballentine, Decatur, Ala. (to The Chemstrand Corp., Decatur, Ala.).

Ethylene glycol and dimethyl terephthalate are reacted in the presence of a catalytic amount of an aliphatic diketone metal enolate containing from five to eight carbon atoms and whose carbonyl groups are separated by one carbon atom. The metal is selected from the group consisting of cadmium, cobalt, manganese, magnesium, and zinc. The reaction is carried out at elevated temperatures until no further methanol is liberated, and is continued until a linear polyester having the desired degree of polymerization is obtained.

Process for the Manufacture of a Synthetic Leather. No. 2,858,570. John C. Richards, Williamsville, N.Y. (to E. I. du Pont de Nemours and Co., Wilmington, Del.).

A flexible synthetic leather is prepared by associating liquid-swellable fibers with a polymeric thermoplastic binder to form an initial sheet. The sheet is hot pressed and soaked in a liquid which softens the binder and is absorbed by the fibers causing them to swell. The sheet is cooled to set the binder, and the liquid is removed from the fibers causing them to shrink.

Process of Producing Filaments of Vinylidene Chloride Resins Containing a Dimethyl Ester. No. 2,859,089. Robert J. Reid, Canal Fulton, William Mayo Smith, Jr., Cuyahoga Falls, and Byron H. Werner, Akron, O. (to Firestone Tire & Rubber Co., Akron, O.).



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Homopolymers of vinylidene chloride are extruded and oriented by stretching them at least 400% to produce filament of a gage between 0.006-0.015 inch. A processing aid is incorporated into the molten resin which consists of 4-10% by weight of an ester from the group consisting of dimethyl suberate, dimethyl azelate, and dimethyl sebacate.

Process for the High-Frequency Welding of Cellular Bodies of Thermoplastic Materials. No. 2,859,153. Conrad Zucht, West-Berlin-Siemensstadt, Germany. (to Reinhard Staeger, Koniz, Switzerland).

The surfaces to be welded are provided with a thin, non-volatile layer of substance having a high dielectric constant with a dipole moment between 1-4. The surfaces are placed in contact, and electrodes are applied along the weld seam on both sides without exerting any substantial pressure.

Applications

Method of Making a Flexible Hose. No. 2,855,975. John R. Ritchie and John R. Ritchie, Jr., Minneapolis, Minn.

A flexible tube which is impervious to water, moisture, air, organic solvents alcohol oils, and acids, is made by surrounding a flexible rubber tube with a pervious fabric covering. The fabric is impregnated with a heated mixture of polyvinyl alcohol and water. After the mixture has dried, another fabric covering is applied over which is coated a layer of synthetic rubber.

Resiliently-Backed Plastic Bearing. No. 2,851,314. John B. Thomson, Manhasset, N.Y.

This shaft has an inner liner of nylon which is fitted to, and circumferentially movable within, the outer housing. The liner, which is precisely fitted to the shaft, is restrained from axial movement. It is very thin in relation to its circumference, and is provided with a longitudinal slot which is at least as wide as the liner's circumferential expansion under operating conditions. A resilient backing member surrounds the liner.

Fireproof Door Core of Phenol Formaldehyde, Wood Chips, and Diammonium Phosphate. No. 2,859,187. Leonard A. Ropella, Marshfield, Wis. (to Roddis Plywood Corp., Marshfield, Wis.).

The core is made up of wood chips; a thermosetting phenol-formaldehyde condensation product binder; an inert mineral filler; and diammonium phosphate crystals. After the binder has set, the core has a density of 0.70.

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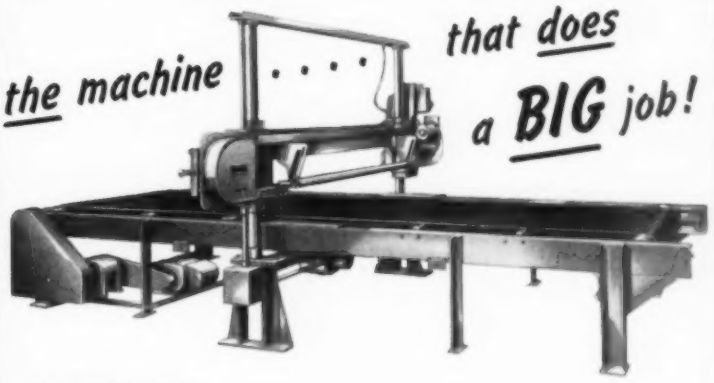

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Polyurethane foam slabs are separated by elongated solid polyurethane foam members arranged in checkerboard fashion. The sides are made of polyurethane foam strips.

Plastic Tubing. No. 2,854,031. Chase Donaldson, Mount Vernon, N.Y.

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Price Changes and Additions

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55-3750	lb.	$3.45
XR 55-3770	lb.	3.25
Reduced GT 55-3325, GT 55-3345	lb.	.90

Fillers

Cab-o-sil H-5	lb.	.74 / 1.35
HS-5	lb.	.84 / 1.45
M-5, M-6, M-7, MS-7	lb.	.66 / 1.25
Calcene CO	ton	105.00 / 125.00
NC	ton	80.00 / 100.00
TM	ton	82.50 / 102.50
Hi-Sil 233	lb.	.0825/ .0975
X303	lb.	.40 / .45
Silene EF	lb.	.06 / .07

Plasticizers

Elastex 37-R	lb.	.50 / .515
82-P	lb.	.285 / .325
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Dibutyl phthalate	lb.	.26 / .40
Sebacate	lb.	.655 / .745
Dicapryl phthalate	lb.	.25 / .39
Di-iso-decyl phthalate	lb.	.26 / .40
Di-iso-octyl adipate	lb.	.40 / .495
Dimethyl sebacate	lb.	1.28 / 1.37
Dioctyl phthalate	lb.	.25 / .39
Dioctyl sebacate	lb.	.5925/ .6825
Harflex 330	lb.	.4425/ .5325
375	lb.	.7425/ .83
Iso-octyl-decyl phthalate	lb.	.255 / .395
Sebacic acid, CP	lb.	.695 / .815
Purified	lb.	.655 / .775

Resins & Molding Compounds

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Fiberfil nylon G-1, G-3, std.	lb.	1.55 / 1.80
Colors	lb.	1.65 / 2.10
G-2 std.	lb.	1.75 / 2.22
Colors	lb.	1.85 / 2.52
Plaskon 8200, 8201 nat.	lb.	1.18
Black, White	lb.	1.28
Other colors	lb.	1.37

Styrene

Cycolac C, black	lb.	.60 / .72
Pellets, T, H, L, nat. and standard colors	lb.	.58 / .70
Custom colors	lb.	.58 / 1.10
Premium colors	lb.	.61 / 1.13
Powdered resins, T, H, L	lb.	.53 / .65
Fiberfil styrenes, G-30, std.	lb.	.535 / .985
Colors	lb.	.635 / 1.325
G-31	lb.	.74 / 1.19
G-32, nat.	lb.	.49 / .94
Colors	lb.	.59 / 1.19

Stabilizers

National Lead, lead oxides:		
Litharge	lb.	.1375
Fumed	lb.	.1385
Red lead, dry, 95%	lb.	.1425
97%	lb.	.1445
Orange mineral	lb.	.1660
White lead, basic carbonate	lb.	.17 / .18
Basic silicate, 45X	lb.	.1575/ .1675
Silico chromate, basic lead, M50	lb.	.1950/ .2050

CALENDAR of COMING EVENTS

June 30
SPE Detroit Section RETEC, Plastics in the Automotive Industry. Detroit, Mich.

July 6-10
Gordon Research Conferences. Polymers. Colby Junior College. New London, N.H.

August 9-12
ASME-AICE Heat Transfer Conference. University of Connecticut, Storrs, Conn.

September 10-11
ASME Wood Industries Conference. Multnomah, Portland, Ore.

October 7
SPE Cleveland Section RETEC. Vinyl Plastics. Cleveland, O.

October 16
SPE Buffalo Section RETEC. Plastics Finishing. Niagara Hotel, Niagara Falls, N.Y.

November 8-10
Toy Production Show (originally scheduled for April 14-16). New York Trade Show Building, New York, N.Y.

Domestic Production and Sales of Plastics and Resin Material, January and February, 1959

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of January and February, 1959. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

	January, 1959		February, 1959	
	Production	Sales	Production	Sales
Cellulose Plastics:[2]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,781,417	1,479,147	1,414,231	1,376,857
Sheets, 0.003 gage and over	1,894,952	1,602,610	1,670,108	1,483,359
All other sheets, rods, and tubes (including other cellulose plastics)	903,928	772,938	723,407	799,742
Molding and extrusion materials (including other cellulose plastics)	8,810,467	8,409,638	7,945,224	7,409,513
Nitrocellulose sheets, rods, and tubes	293,683	175,895	289,706	181,712
TOTAL	13,684,447	12,440,228	12,051,676	11,251,183
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	17,241,585	16,626,449	16,740,057	16,313,419
Bonding and adhesive resins for—				
Laminating (except plywood)	5,855,854	3,681,949	6,144,291	3,972,792
Coated and bonded abrasives	1,253,749	1,181,531	1,175,767	1,071,640
Friction materials (brake linings, clutch facings, and similar materials)[3]	1,305,950	1,014,732	1,371,867	1,164,278
Thermal insulation (fiber glass, rock wool)	3,904,460	4,007,666	3,968,916	3,731,064
Plywood	4,891,255	4,011,466	4,352,233	3,637,711
All other bonding and adhesive uses	5,720,822	5,459,197	4,959,334	4,601,253
Protective-coating resins unmodified and modified except by rosin	2,434,845	1,933,080	2,252,079	1,641,929
Resins for all other uses	3,834,793	3,694,223	3,150,126	2,928,038
TOTAL	46,443,313	41,610,293	44,114,670	39,062,127
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,870,594	2,956,911	2,996,005	3,009,740
Paper-treating and paper-coating resins	2,301,844	2,015,656	2,192,136	1,908,422
Bonding and adhesive resins for—				
Laminating	2,557,192	1,985,668	2,714,146	2,032,130
Plywood	10,441,612	9,383,518	9,402,401	8,807,772
All other bonding and adhesive uses	1,950,835	1,792,506	1,448,916	1,662,252
Protective-coating resins, straight and modified	3,006,770	2,229,000	2,607,037	2,092,626
Resins for all other uses, including molding	9,040,106	9,059,724	8,939,052	9,268,038
TOTAL	32,168,953	29,422,983	30,299,693	28,780,980
Styrene Resins:				
Molding and extrusion materials:				
Straight polystyrene	19,920,191	18,658,869	19,241,957	17,811,881
All other	27,048,134	23,550,232	26,454,161	23,832,719
Protective-coatings	8,029,230	6,627,714	6,899,412	6,430,533
Textile and paper treating and coating resins	3,550,588	3,030,028	3,683,858	3,092,593
All other uses	11,722,439	12,870,645	11,524,996	12,387,685
TOTAL	70,270,582	64,737,488	67,804,384	63,555,411
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		5,959,058		5,590,433
Sheeting (resin content)		8,050,020		9,094,055
Molding and extrusion (resin content)		23,818,455		22,638,239
Textile and paper treating and coating (resin content)[3]		5,139,419		5,052,118
Flooring (resin content)		11,707,525		11,175,712
Protective coating (resin content)		2,441,706		2,325,343
All other uses (resin content)		5,987,929		7,312,271
All other vinyl resins for—				
Adhesives (resin content)		3,533,472		4,138,566
Protective coatings (resin content)		2,555,192		2,651,524
All other uses (resin content)		10,092,450		9,949,242
TOTAL	83,658,604	79,285,226	83,682,327	79,927,503
Coumarone-Indene and Petroleum Polymer Resins	20,186,878	20,950,601	21,403,604	21,205,229
Polyester Resins:				
For reinforced plastics	9,276,189	8,171,888	9,032,880	8,515,058
For all other uses	1,764,520	1,697,347	1,679,238	1,498,667
TOTAL	11,040,709	9,869,235	10,712,118	10,013,725
Polyethylene Resins:				
For film and sheeting		29,168,744		27,667,086
Molding materials		11,644,008		12,842,066
Extrusion materials		7,454,535		7,328,637
For all other uses		32,129,363		32,376,114
TOTAL	87,329,294	80,396,650	78,419,420	80,213,903
Epoxy Resins:				
For protective coatings	878,925	1,401,229	868,076	1,210,028
For all other uses	3,875,358	1,881,777	2,776,272	1,621,392
TOTAL	4,754,283	3,283,006	3,644,348	2,831,520
Miscellaneous Synthetic Plastics and Resin Materials, Including Silicone Resins	18,302,955	15,733,992	17,947,719	15,953,098
GRAND TOTALS	367,653,140	357,729,702	370,079,959	352,794,679

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
SOURCE: United States Tariff Commission, Chemical Division.

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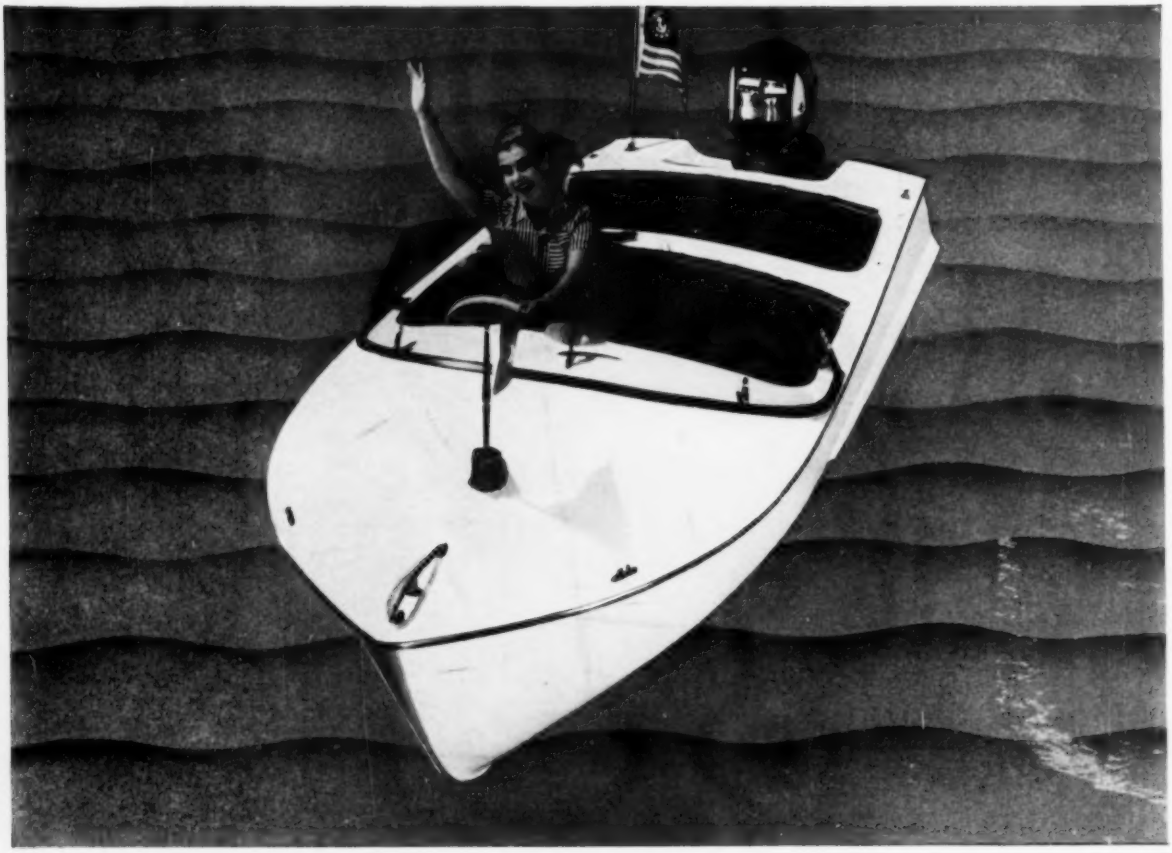

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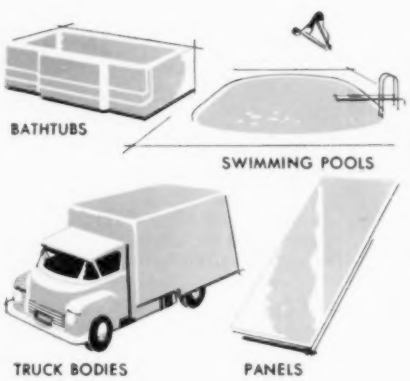

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